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Both Associate Professors of Applied Mechanics
Purdue University

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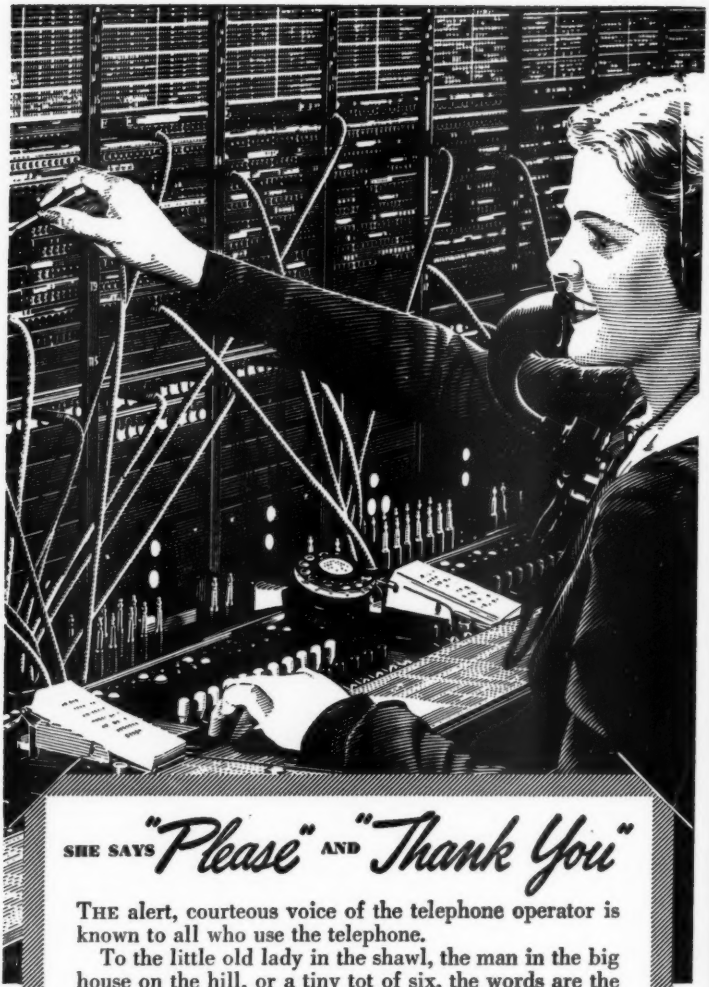

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TEXAS A. & M. COLLEGE

By T. B. KETTERSON

Second largest engineering school in the country in point of enrollment, and oldest state-supported institution of higher education in Texas is the Agricultural and Mechanical College of Texas, host for the forty-sixth annual meeting of the Society for Promotion of Engineering Education which will be held June 27–30.

Engineering graduates of the college have made their mark in virtually every section of the world, but Texas A. & M. is not known alone for its engineering work. It also is the largest agricultural school in the world, in point of enrollment, and it can list a number of "firsts," "largests" and "bests" in college fields.

Located at College Station, Texas, the Texas A. & M. campus is some 4,000 acres in extent, including farms and pastures. The main campus, covering 400 acres, has 60 permanent buildings, including 12 dormitories, but dormitory space will be doubled within a year by buildings to be financed by a recent $2,000,000 loan from the Reconstruction Finance Corporation. The state auditor of Texas recently estimated the value of the college property, buildings and equipment at College Station at more than $17,000,000.

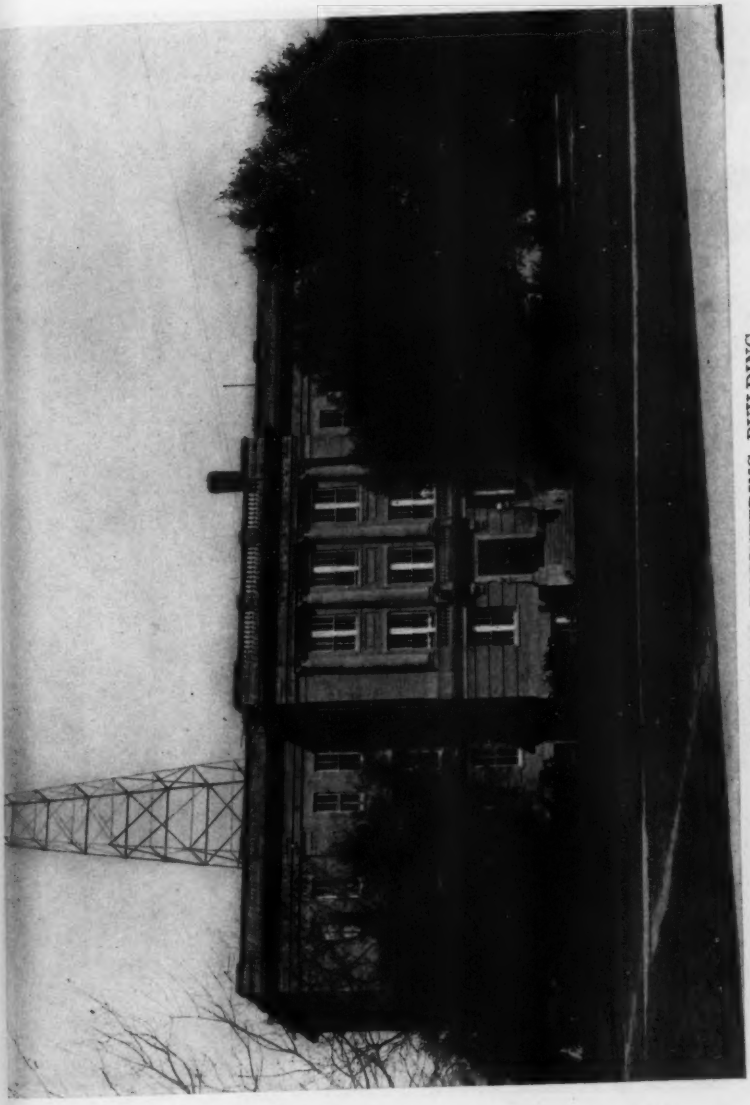
A number of beautiful new buildings have been financed within the past ten years by the college's one-third share of the income from the A. & M.-University of Texas oil land fund. Money received from the oil land income cannot be used for operating expenses, however.

Texas A. & M. is within "easy" driving distance of other leading educational institutions of the state, the biggest cities of the state, and, from a recreational standpoint, the leading vacationing, fishing and hunting resorts of this area. Huge industrial plants and the world's largest oil field, the huge East Texas field, also are within 200 miles of the college.

Formally opened Oct. 4, 1876, with scarcely more than a score of students to live and study in its two buildings and a staff of only seven teachers and officials to reside in its five residences, the college has grown year by year until it now has a teaching staff numbering more than 200 and a student body of approximately 5,000. Texas A. & M. is not co-educational, enrollment being limited to young men. The college, in its more than 60 years of life, has awarded degrees to approximately 7,500 graduates.

The college proper, however, is but one phase in the life of

ACADEMIC BUILDING



ELECTRICAL ENGINEERING BUILDING

ADMINISTRATION BUILDING

ADMINISTRATION BUILDING

Texas A. & M., which has as its motto the phrase: "A Service Institution." The college board of directors, which has Dr. F. M. Law, president of the First National Bank in Houston and a former student of the college, as its president, also has direct supervision over the Texas Extension Service, the Texas Agricultural Experiment Station, the Texas Forest Service and the Texas Engineering Experiment Station, all of which have headquarters on the campus.

Also operating under direction of the board are three branch colleges, including John Tarleton Agricultural College at Stephenville and North Texas Agricultural College at Arlington, both junior colleges; and Prairie View State Normal and Industrial College for Negroes at Prairie View.

Through county agricultural agents and county home demonstration agents, the Extension Service touches the life of virtually every farmer in the state. The Agricultural Experiment Station operates nearly a score of sub-stations, and the Forest Service keeps tab on state timberlands as one of its many duties. The Engineering Experiment Station constantly is seeking methods to aid industry.

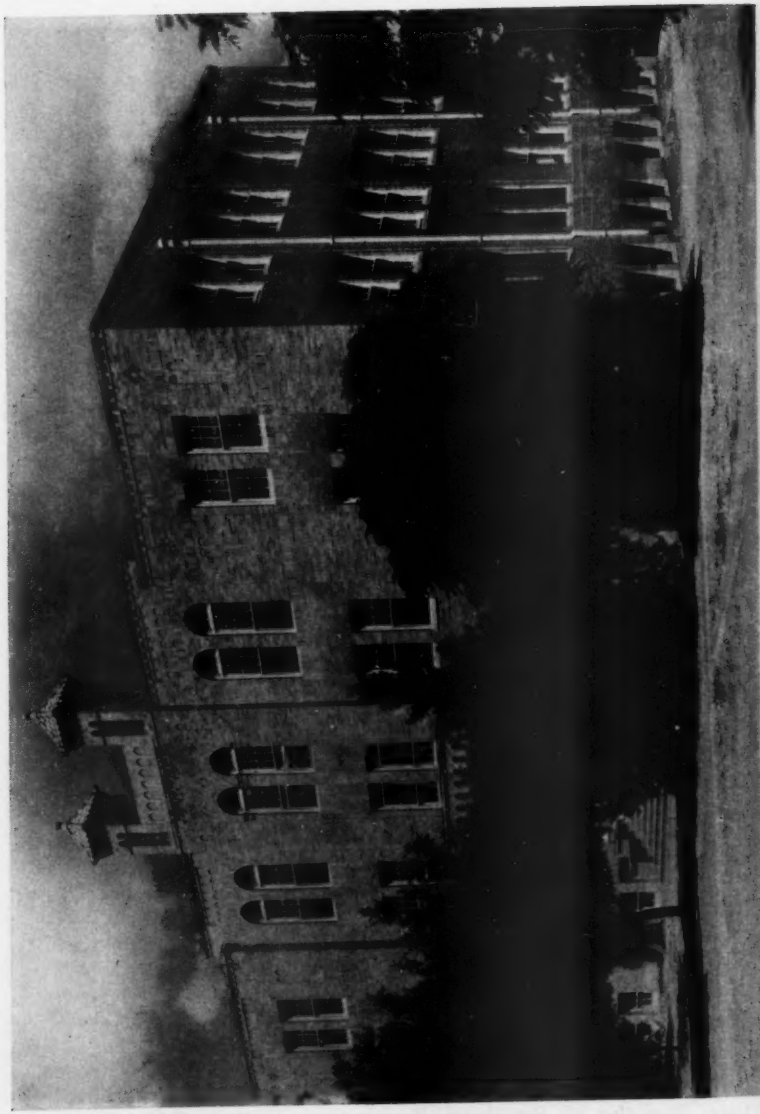
As one of the Land Grant Colleges, Texas A. & M. has one of the largest Reserve Officers Training Corps units in the country and is one of the few colleges or universities given an M.C. (Military College) rating by the War Department. The past Spring its R.O.T.C. graduating class of 211 cadets was the largest in the country. Twenty-one years ago the college stood first in number of graduates who entered the service of the flag, according to a survey made by the New York Sun of the participation of college graduates in the World War.

An institution is no bigger, no better than the men behind it, and the people of Texas and other states have shown full confidence in the abilities of the men actively in charge of Texas A. & M. Chief administrative officer of the college is Dr. T. O. Walton, president, under whose wise guidance since 1925 the college has had its greatest growth of record.

Dr. Frank C. Bolton, vice-president and dean of the college, also is a vice-president of the S. P. E. E. He was dean of the school of engineering for years but relinquished that position the past September upon assuming the vice-presidency of the college.

Gibb Gilchrist, now dean of the school of engineering, for years was state highway engineer for the State of Texas, and he is recognized as one of the foremost civil engineers in the country.

The college offers work leading to six different degrees, these being Bachelor of Arts, Bachelor of Science, Bachelor of Architecture, Bachelor of Petroleum Engineering, Doctor of Veterinary Medicine, Master of Science and Doctor of Philosophy. Schools



MECHANICAL ENGINEERING BUILDING

MECHANICAL ENGINEERING BUILDING

PETROLEUM ENGINEERING, GEOLOGY AND ENGINEERING EXPERIMENT STATION BUILDING

included in the college are those of agriculture, arts and sciences, engineering, veterinary medicine and the graduate school.

The first semester of the current school year saw a total of 2,417 students enrolled under the banner of the school of engineering. They major in one of the 11 different fields offered by the school.

Curricula for the departments of civil engineering, electrical engineering, mechanical engineering and petroleum engineering have been accredited by the Engineers Council for Professional Development within the past few months.

Petroleum engineering currently attracts the most students, a total of 785 cadets having registered for this work. Mechanical engineering ranked next in line numerically with 568 students. Chemical engineering attracted 334 students and electrical engineering enrolled 332. Work also is offered in fields of architectural engineering, architecture, civil engineering, engineering administration, geological engineering, industrial education, municipal and sanitary engineering and textile engineering.

In addition to courses controlled by the school of engineering, a total of 140 Texas A. & M. students are working toward B.S. degrees in agricultural engineering, which comes under supervision of the school of agriculture.

As much laboratory and other practical instruction as possible is given students. Electrical engineering students, for instance, are in charge of operating Radio Station WTAW, the college-owned broadcasting unit. This station, incidentally, was the first, so far as is known, to broadcast a sports event.

Texas A. & M. annually sponsors nearly a score of "short courses" lasting from three days to a full week, and the school of engineering plays a major part in these. Departments of the school conduct short courses for policemen, firemen, highway engineers, water works operators, public utility engineers, cottonseed oil mill operators and laundry operators.

Texas A. & M. for years has been known as a "poor man's school," and the past few years have seen this brought out more clearly than ever before. Approximately one-half of the cadets live in the college dormitories and eat in the dining hall, the largest dining hall under one roof in the world, but nearly 1,000 students form one of the largest college co-operative systems in the country. Grouped in "project houses" and supervised by the college and the matrons of each house, the students share all living expenses, many of them bringing much of their food from home. Other items are bought on a wholesale basis for all of the houses. Only the past Summer the college itself built 14 of these "project houses" on the campus, other houses being rented near the campus or in Bryan five miles to the North.

ENGINEERING ECONOMY IN RELATION TO CHEMICAL ENGINEERING INSTRUCTION *

By W. M. COBLEIGH

Dean and Professor of Chemical Engineering, Montana State College

"Three basic aspects of every engineering project are: 1. Technical, 2. Economic, 3. Social. Education should include the basic facts and principles of all three. At present the terms 'Economics' and 'Sociology' are too umbrella-like in their spread. The modern trend in engineering education is the recognition of these three basic fields of thinking and training, and the endeavor to gather teaching material and teaching methods which will form as firm a basis for the economic and social advance of the engineer as the technical sciences afford for advancement in the technical field." (This quotation is taken from the S. P. E. E. Report: Progress in Engineering Education, 1935–36; published in the JOURNAL OF ENGINEERING EDUCATION, page 550, April, 1937.)

This quotation forms the basis for the introduction to this paper and the premise on which the writer sets forth the relation of engineering economy to chemical engineering training.

The quotation carries three implications. As related to chemical engineering instruction, these implications are as follows:

1. That chemical engineering training with its foundation on the technical sciences is the basis for successful achievement in the technical aspects of chemical engineering practice.
2. That it is now advisable to gather "teaching material and teaching methods" that will provide equal chances for success in the economic and social aspects of chemical engineering practice.
3. That in engineering practice, it is not possible to separate completely the technical aspects and the economic aspects of an engineering project, and that the trend in engineering schools is to bring about a closer union between the technical and the economic considerations in courses of instruction.

To provide information for students at Montana State College about the subject matter requirements of chemical engineering edu-

* Presented at Conference on Engineering Economy at Cambridge Meeting S. P. E. E., July 1, 1937.

cation, the following statement was prepared two years ago for discussion in student seminars:

The Chemical Engineer and the Process Industries.—"A knowledge of chemistry, the other technical sciences, the general principles of engineering, economics, engineering economy and the unit operations of chemical engineering is the basis for the development, design, construction, operation and management of the chemical process industries and by these means raw materials are changed into marketable products."

To help the student in an understanding of chemical engineering training, the local curriculum was examined in the light of the above subject matter requirements. With respect to economics, the following instruction is required:

1. Elementary and fundamental principles of engineering economy, included in an engineering problems course offered in the sophomore year.
2. Two courses in economic theory taught in the junior year by the Economics Department.
3. One course in engineering economy taught by the Department of Industrial Engineering in the junior year.

This fundamental training serves as a preparation for applying the principles of engineering economy to chemical engineering courses of instruction.

To emphasize the role of engineering economy, students were provided with the following classification of the field of chemical engineering on a functional basis. This classification also assists students in their vocational choices by taking due account of their aptitudes and interests for professional service.

Research and Process Development

New products and their sources
Raw materials problems
Feasibility of a process
Laboratory research and process development through pilot plant and semi-works stages.
Production costs
Financial appraisal

Design and Construction

Plant design according to process flow sheet
Selection of equipment used in the unit operations of the plant
Economy in design
Plant location
Plant construction

Production and Operation
- Administration
- Production management
- Plant supervision
  - Laboratory control
  - Operating personnel
    - Executives
    - Employees
    - Industrial hazards
    - Operating costs

Marketing and Sales
- Market appraisals
  - Customer research
  - Distribution channels
- Sales organization
  - Pricing and credit policies
- Market and sales development
  - Advertising
  - Technical publicity

If a chemical engineering department has reason to be governed by the trend stated in the S. P. E. E. Progress Report, then "teaching material and teaching methods" can be developed for the purpose of applying the principles of engineering economy to the cost aspects of the four functions stated above, viz.: research and process development, design and construction, operation, marketing and sales.

Research and Process Development.—The first question that arises in the development of a new process is "Will it pay?" There is a wealth of available material in the literature along this line. No effort is made in this paper to offer a complete bibliography. However, the stages in process development have been presented very effectively by Vilbrandt,* and by Darlington.†

When the process development has advanced from the laboratory stage to the pilot or semi-commercial plant stage, there arises the problem of pre-determining profits. In this field of process development, Wolford ‡ has described a procedure for forecasting the financial prospects of a new line of manufacture and also

* "The Place of the Pilot Plant in Process Development," F. C. Vilbrandt, *Trans. Amer. Inst. Chem. Eng.*, 31, 494 (1935).

† "How We Use Our Semi-Works," C. J. Darlington, *Trans. Amer. Inst. Chem. Eng.*, 31, 506 (1935).

‡ "From 'Semi-Plant' to 'Full Scale,'" E. Y. Wolford, *Ind. & Eng. Chem.*, 3, No. 22, Nov. 20 (1925); "Predetermining Profits," E. Y. Wolford, *Chem. & Met. Eng.*, 33, No. 8, 466 (1926).

indicates how experimental operating data furnishes the basis for determining the ultimate cost of production. He also shows how to prepare a projected annual balance sheet.

The economic principles involved in the answer to the question "Will it pay?" as it applies to the problem of research and process development would seem to involve the following fundamentals:

1. An economic estimate of the capacity of the proposed plant through a market analysis.
2. A determination of estimated expenses, including fixed and operating charges. Under this item would naturally come the following classifications:
   - *a* PRODUCTION including the purchase of materials, hiring of labor, and such other operations as are necessary or incident to the making of the product, such as heat, light, power, repairs, maintenance, depreciation, etc.
   - *b* DISTRIBUTION including advertising, selling, warehousing, shipping, and delivery of the product to the customer.
   - *c* FINANCE including the providing of the capital necessary to carry on all activities.
   - *d* GENERAL ADMINISTRATION including the general supervision of all activities.
3. The determination of unit cost.
4. The determination of the rate of return on the investment.

Knowing the total capacity and an estimate of the total expenses, it is an easy matter to determine the unit cost. However, to answer the question "Will it pay?" it would be necessary to continue our analyses and compute the net annual operating profit to be expected, and to compare this profit with the actual invested capital necessary to produce the profit. If this ratio is sufficiently greater than the ordinary rate charged for borrowed capital, such as to provide for all estimated additional risks, then the new enterprise would be considered an economic project.

Design and Construction.—Should the project prove to be economical, then the second function would naturally center around an economic design and construction of a plant to produce the estimated quantity.

Again we find under this particular function a new set of fundamental principles of engineering economy as follows:

1. Plant location

Primary factors	Secondary factors
Market	Legislation
Raw Materials	Climate
Labor	Advertising value
Transportation	Financial aids
Power and fuel	Banking facilities
Water supply	

2. Economic selection of equipment
3. An economic design to house the proposed equipment for both present and future demands

Operation.—A study of a chemical process industry reveals the fact that raw materials pass through the plant and the properties are altered at various stations through the operation of what is known as chemical engineering unit operations, of which the following is a partial list: heat flow; fluid flow; mechanical separation including filtration; vaporization phenomena including distillation, evaporation and drying; absorption; mixing, etc.

The total operation cost is in part the sum of the costs of operation of the above units. In controlling production costs, the following principles of engineering economy are involved:

1. Manufacturing lot sizes
2. Replacement studies
3. Additional investments to reduce operating costs
4. Increment costs
5. Proper analyses of sunk costs involved in replacement studies
6. Load factor and capacity studies
7. Depreciation economy studies
8. Minimum cost point

Marketing and Sales.—The last function, marketing and sales, should cover both present and future possible markets and becomes an essential part of any program leading to the establishment of a new engineering enterprise. Naturally the owners of the proposed enterprise would be concerned in a complete analysis of the following engineering economy studies:

1. The extent of the local demand
2. Other markets
3. The prospective future demand
4. Existing and probable future competition

The above outline is made for the purpose of suggesting teaching material for cost studies. How much of this material could be

utilized in any given training program would be a matter for the teachers in charge of the instruction to determine. On the other hand, no doubt, there are some who would doubt the advisability and also the possibility of including a large program of cost studies. That is a matter for the individual teacher to decide. The purpose has been to suggest possibilities.

From the foregoing discussion, it appears that the writer favors courses in economic theory and engineering economy as prerequisites to the subsequent cost studies conducted in chemical engineering instruction. As a matter of fact, for the last twelve years the author has required courses in economic theory and engineering economy of chemical engineering juniors as a preparation for cost studies that are undertaken in the senior year.

Inspection Trips and Engineering Economy.—Student interest in the economics of unit operations can be developed in the studies conducted on inspection trips to industrial plants. Recently engineering seniors were inspecting a modern crushing and grinding plant. At first, attention was focused on the technical aspects of crushing and grinding. These involved the number of stages, the design and capacity of each machine in the set-up. Two of the units were for coarse crushing and were operated in open circuit. Two machines for intermediate crushing were operated in closed circuit with varying circulating loads. The last unit was for fine pulverizing and was operated in closed circuit. As soon as the students had examined the technical operation of the plant, they immediately became interested in operating costs. Fortunately, the guide in charge of the party was in a position to inform the students how all the variables had been adjusted by engineering tests so that the crushing and grinding costs were known to be a minimum for this particular installation. The students displayed as much interest in the operating costs as they did in the technical operation. This inspection was followed by classroom studies from the standpoint of economic selection of equipment and operation for minimum cost.

In another inspection, the students who were studying the first carbonation station in a sugar factory, learned that an installation of plate and frame filtration presses used for the filtration of carbonation juice, had been discarded and that a Dorr thickener and Oliver filters had been substituted. The first observations of the students were limited to the technical aspects of the installation. Very soon, the discussion turned to an economic comparison of the two installations. Fortunately, the guide in charge of the party was in a position to give the results of comparative cost studies and also explain the economic advantages of the new installation from the standpoint of operation.

On the other hand, in the study of a filter installation in another plant, it appeared that a Moore filter had been substituted for an Oliver filter after engineering tests had been made. Here again, the economic aspects, as well as the technical, controlled the change in the filtering procedure.

Inspection trips of this kind serve as a good basis for classroom instruction in both the technical and the economic aspects of the unit operations of chemical engineering.

The writer is indebted to Professor Merrill R. Good, Head of the Department of Industrial Engineering, for assistance in coordinating the principles of engineering economy with the four functions of chemical engineering.

TECHNICAL AND BUSINESS OPTIONS IN ENGINEERING CURRICULA*

By C. L. EDDY

Case School of Applied Science

The present Business Option, offered to all seniors at Case School of Applied Science, has been given for the past three years. It is the outgrowth of the conviction on the part of the Administration that every engineer should have some training in the fundamentals of business, not with the idea of producing a new or different type of engineer but only a differing orientation among engineers in long established branches of the profession.

The practice of engineering is as much a matter of the application of business principles as of engineering. It follows, therefore, that a graduate, if he is to practice his profession, should have not only fundamental training in engineering technology but also fundamental training in business. The belief is that this need ex-

CASE SCHOOL OF APPLIED SCIENCE

DEPARTMENT OF ENGINEERING ADMINISTRATION

Business Option

Senior Year

First Term

Subject	Hours per Week			Credits
	Class	Lab.	Prep.	
Business Fundamentals	3		3	6
Accounting	3	3	3	9
Industrial Business Practice	3		3	6
Technical Subjects	12	6	13	29
Second Term				
Business Law	3		3	6
Cost Accounting	3	3	3	9
Engineering Economy	3		3	6
Technical Subjects	6	12	6	24

* Presented at the Industrial Engineering Conference, 45th Annual Meeting, S. P. E. E., Cambridge, Mass., June 30, 1937.

CASE SCHOOL OF APPLIED SCIENCE

DEPARTMENT OF ENGINEERING ADMINISTRATION

Schedule

The Business Option

First Term
1936–37

Number of Weeks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Subject		Mon., Sept. 28, 1936						Mon., Nov. 9, 1936		Mon., Nov. 23, 1936	Thanksgiving		Wed., Dec. 9, 1936		Christmas	Vacation			Thur., Jan. 28, 1937	Final Exams.
Business Fundamentals	Registration							Business Unit—Sec. 1			Purchasing and Merchandising			Business Unit—Sec. 2						
								Reports—Sec. 2			Secs. 1 and 2			Reports—Sec. 1						
Accounting								Section 1												
								Section 2												
Industrial Business Practice								Production—Sec. 1						Production—Sec. 2						
								Labor Problems—Sec. 2						Labor Problems—Sec. 1						

tends through all branches, possibly in varying degree, and is not peculiar to the mechanical field. However, in this field there is no doubt of the need for an understanding of the economic as well as the technical phases of the engineering profession.

Probably every modern engineering college is called upon to produce two kinds of graduates. One is the highly trained engineer who expects to devote his life to research and development and the other the engineer who expects to find his employment in some functional division of business or industry and whose subsequent promotion is along executive lines.

Surveys of the employment of Case graduates indicate that approximately 70 per cent belong to this second class. Such a man is confronted with problems of economic selection, annual costs, organization, finance, distribution of costs, unit cost of products and management as well as the social significance of his acts. Without some training along these lines in college he is apt to criticize his Alma Mater for not properly orienting him to the work he is to do after graduation.

With four years of faculty emphasis upon the purely technical work in college, it is not surprising that the graduate is led to believe that industry is going to place the emphasis in the same place. That industry does not so place the emphasis at all times is a source of disappointment to many engineering graduates. They think that they have a profession but find that they do not—that is according to their meaning of the word. They think that they are to be segregated to practice the profession of engineering and are confused when they find that they are involved in the engineering project where they need something besides their strictly technical training.

Whatever the justification for giving some business training to those men who are expected to enter the industries, it is not sufficient to warrant slighting, in any way, the training of men who are planning futures in research and development. These men often find that the usual four years course in an engineering college is not sufficient to give the required degree of training demanded and that it is desirable to devote additional years to study. Upon these men the colleges depend to develop leadership in the fields of research and engineering and it is the hope and aim of every college to produce such men.

However, both classes of graduates should not be forced entirely through the same mould. Both need training in the fundamental sciences, drawing, history, English, economics and sociology. Both need instruction in the application courses but where the separation should come is largely a matter of judgment.

At Case the Business Option was introduced at the beginning

of the senior year into a curriculum which already offered considerable choice in the matter of options. This is a group option open to all seniors and amounts in time to approximately one-half of the senior year. Thus a senior who so desires may divide his time about equally between business and technical subjects.

The time which has been allotted to this option consists of three 3 hour periods of recitation and one 3 hour period of laboratory each week. In some instances the 3 hour ribbons of time have been cut into blocks in order to include all of the subjects in which it is desired to give some instruction.

Form No. 1. Sheets 1 and 2 show schedules for men taking the Technical Option and the Business Option in the Mechanical Engineering department. These schedules are more or less typical of the schedules of men from the other departments, although no other department offers quite the latitude in choice of technical options as does this one. It will be seen that the technical subjects required

FORM 1

PAGE 1

Case School of Applied Science
Mechanical Department

First Term

Technical Option		Schedule	Business Option	
Hrs. per Week		Subjects	Hrs. per Week	
Rec.	Lab.		Rec.	Lab.
3		Power Plant Engineering		
3		Machine Design	3	
3	2	Electrical Engineering	3	2
		Business Fundamentals	3	
		Industrial Business Practice	3	
		Accounting	3	1
9	9	Options—To be selected from list below	6	6
		Steady Flow Machinery		
		Industrial Plants		
		Aerodynamics		
		Industrial Combustion Engines		
		Marine Engineering		
		Advanced Strength of Materials		
		Heating and Air Conditioning		
		Refrigeration		
		Statically Indeterminate Str.		
18	11	Total Hours per Week	21	9

FORM 1

PAGE 2

Case School of Applied Science
Mechanical Department

Second Term

Technical Option		Schedule	Business Option	
Hrs. per Week		Subjects	Hrs. per Week	
Rec.	Lab.		Rec.	Lab.
3		Non-Technical Option		
	9	Thesis		9
		Power Plant Engineering	3	
		Business Law	3	
		Engineering Economy	3	
		Cost Accounting	3	3
9	9	Options—To be selected from list below	3	3
		Advanced Machine Design		
		Aircraft Structures		
		Power Plant Chemistry		
		Power Plant Engineering		
		Materials and Processes		
		Cooling and Air Conditioning		
		Automotive Engineering		
		Physical Metallurgy		
12	18	Total Hours per Week	15	15

of the regular Mechanical Engineering seniors (Technical Option) consist of Power Plant Engineering; Machine Design; Electrical Engineering in the first term and Thesis in the second term. The Business Option men get all of these subjects by taking Power Plant Engineering in the second term instead of the first and omitting the non-technical option required of the technical men in the second term. In addition to the required subjects given above, the technical men select 9 hours of recitation and 9 hours of laboratory each term from a group of eight or nine optional subjects which are listed on Form No. 1. The Business Option men select an average of four and one-half hours of recitation and four and one-holf hours of laboratory each term from the same optional subjects. Thus it is seen that the Business Option men get all of the essential technical work required for graduation in the Mechanical department but substitute their business subjects for some of the optional technical subjects. This difference of required technical

work is partially made up by some of the subjects in the Business Option. If Industrial Business Practice (Production Control and Labor Problems) in the first term and Engineering Economy in the second term were considered technical rather than business subjects, then the men taking the Business Option come within 3 hours of having as much technical work as the Technical Option men. This difference in the amount of technical subject matter is not considered sufficient to warrant a different designation upon graduation of the Business Option men and they are graduated with the same degree as given to the Technical Option men.

It will be noted that the Business Option schedule calls for 3 hours per week more of recitation and 2 hours less of laboratory than for the Technical Option for the first term and 3 hours less of laboratory per week in the second term, making a net gain of one hour per week required of the Business Option men.

Course Content

The usual problem presents itself of what subjects should be given in the time allotted to this option. Keeping in mind that the

FORM NO. 2

Sheet 1

First Term

Business Fundamentals—3 hours per week, lectures and recitations. This time is divided about equally among three subjects:

1. *The Business Unit*
   - Function, Justification, Incentive
   - Formation, Operation and Control
   - Sole Owner, Partnership, Corporation
   - Public Relations
   - Gross Income, Total Expenses—How affected
   - Interest Calculations, Depreciation, Sinking Funds
   - Organization—Scalar, Functional

2. *Merchandising and Purchasing*
   - Significance of Functions
   - Procedures
   - Classification
   - Motives

3. *Oral and Written Reports*
   - Definition
   - Present-day Need
   - Importance
   - Qualification
   - Subjects for Development

Text—Lecture Notes and "Handbook of Business Admin." by Donald.

FORM NO. 2

SHEET 2

ACCOUNTING—3 hours per week, lectures and recitations and one 3 hour laboratory period.

The basic principles of accounting, including the general theory of accounts, systems of recording entries, preparation of financial statements, etc., with special reference to the productive industries.

Text—"Accounting Principles" by McKinsey and Noble.

INDUSTRIAL BUSINESS PRACTICE—3 hours per week, lectures and recitations.

This time is equally divided between two subjects:

1. *Production and Production Control*
   - Management
   - Organization
   - Waste
   - Plant—Location and Layout
   - Equipment
   - Simplification and Standardization
   - Stores Control and Inventory
   - Operation Study and Economic Policies

2. *Labor Problems*
   - Human Behavior
   - Lot of Average Worker
   - The Direction of Man-power
   - Human Tendencies or Impulses
   - The Manager's Desires in Regard to Labor
   - The Worker's Requirements as to The Job

Text—Lecture Notes and "Handbook of Business Administration" by W. J. Donald.

FORM NO. 2

SHEET 3

Second Term

Each subject given in the second term is a full 3 hour course.

BUSINESS LAW—Lectures and recitations.

Study is made of the law of contracts, agency, sales, property and patents.

Text—"Law of Business" by Bauer and Simpson.

COST ACCOUNTING—3 hours per week, lectures and recitations and one 3 hour laboratory period.

Methods of determining the elements of costs and of distributing them for both job and process plants.

Text—"Cost Accounting for Control" by Sanders.

ENGINEERING ECONOMY—Lectures and recitations.

Application of the principles of engineering economy to materials, construction, power supply and distribution, machinery and equipment.

Text—"Principles of Engineering Economy" by Grant.

course is intended primarily for those men who expect to enter the commercial, industrial and executive branches of engineering, the decision was reached that these men should have some business training along with their engineering if they were to be oriented properly. It was desirable that they have a general view of the business unit, how it is organized, financed, operated and controlled. They need to know that in industry emphasis is placed upon the profit motive; that in some cases at least the dollar sign *has* replaced the integral sign and the factor of persuasion often encroaches upon the factor of safety; that the design of many articles to be manufactured starts with the determination of the price for which such an article can be sold; that this price is not fixed by the cost to produce and to sell but by competition; that no design, however perfect from the standpoint of engineering, is acceptable unless the article can be produced and sold at a profit.

It seems logical to assume, therefore, that these students should understand something of the functions of merchandising and selling and of the fact that these do have a direct bearing upon design and production.

They should have, also, some appreciation of the importance of labor in the production field and have their attention called to some of the problems involved in the handling of men.

It should be recognized that our system of law fixes the rules of the game of business and that some knowledge of these rules is desirable.

Also, since these men are to deal so largely with problems of unit costs and of investment, instruction should be given in accounting, cost accounting and engineering economy.

The selection of the course material to be given has been made with the above requirements in mind and is shown in outline on Form 2.

The teaching is all done by the present faculty except for Merchandising and Purchasing. The course content for this subject is presented by men from industry in a series of lectures covering about six weeks. The Purchasing Agent of a prominent local corporation gives five or six lectures on Purchasing and the Sales Manager of another gives the lectures on Merchandising.

All of the work given in the Business Option is under the direction and control of the department of Engineering Administration, although a large part of the teaching is done outside of this department. For example, "Production and Production Control" is given by the Mechanical department; "Labor Problems" is given by the department of Economics and "Reports" by the department of English. "Engineering Economy" is given by each department graduating students to its own men who take the Business

Option. The object of this arrangement is to secure for the students the application of the principles of economy to their own particular field of engineering. Incidentally, this arrangement has resulted in the introduction of Engineering Economy as a required subject for the technical option men in several of the departments.

In addition to the Business Option, the department of Engineering Administration offers elective courses such as Industrial Accounting, Engineering Law and Estimating. These courses are open to such men of the technical option as are able to fit them into their schedules, either as options or as electives.

The number of men electing the Business Option each year has been uniformly about one-third of the senior class. It is probable that if the men could more accurately foresee the character of their employment after graduation, they would in larger numbers, elect this option. Of the men taking this option about 60 per cent come from the Mechanical department; about 20 per cent from the Electrical department and the remaining 20 per cent from the Civil, Chemical and Metallurgical departments.

There is no discrimination against the Business Option men by employers looking for technical graduates. Probably it would be incorrect to conclude that these men were preferred, although they have been among the first to receive offers of employment each year. Some employers have selected the Business Option men because they have had the business training along with their engineering, thus giving these men an opportunity for employment not open to the technical men.

The business option plan has not been in operation long enough to allow conclusions to be drawn from the records of the men who have graduated, granting that such conclusions could ever be warranted. It is felt, however, that the men with some business training have a better chance to fit into the industrial organization and are better prepared to cope with the problems of production, sales, application and management than those with only the technical training.

TRENDS IN THE TEACHING OF MANAGEMENT AT M. I. T.*

By ERWIN H. SCHELL

In Charge of the Department of Business and Engineering Administration, Massachusetts Institute of Technology, Cambridge, Mass.

In discussing the trends in our teaching of management, I shall aim to carry each cycle of change not only from the past to the present but into the future where lie the problems which we have yet to solve.

First may I give you a brief outline of the activities of our department of Business and Engineering Administration. First and most important is our undergraduate course curriculum which provides a combined training in science, in engineering and in administration. This curriculum which applies to the last three years of the four-year period, serves some 250 to 300 students at any given time, the students being distributed in the sophomore, junior and senior classes. The second responsibility is the presentation of graduate courses leading to a Master's degree, where the enrollment approximates 20 to 25 students. Finally, the department offers a service course entitled "Introduction to Business Management" which may be elected by any engineering student in other courses and which now is chosen by some 50 to 75 students. A considerable number of undergraduates, as well as graduates, also enroll in our elementary accounting courses.

For your interest today I shall deal only with the undergraduate course curriculum provided for students enrolled in our department.

I should tell you that the purpose of this undergraduate curriculum is not to train industrial engineers, although a few of our graduates do enter this professional field, nor is its purpose to prepare industrial executives. Rather is the curriculum designed to fit men for ultimate industrial responsibilities of an administrative nature where the determination of company policy takes place and where external factors involving broad economic trends, finance, marketing and the general social welfare are involved. A small proportion of students who come to the Massachusetts Institute of Technology have the capacity not only to do highly

* Presented at the Industrial Engineering Conference of the 45th Annual Meeting of the S. P. E. E., June 30th, 1937.

creditable work in science and engineering but to show brilliant promise in administrative areas where evenly balanced judgment, a capacity to weigh intangibles, and an extraordinary breadth of social comprehension and sympathy is indispensable. It is to this relatively small group that our department turns its interest.

As the student progresses from the sophomore year through the senior year, the proportion of time assigned to business and economic subjects increases. Yet the total of these hours ranges between one-third and two-fifths of the student's three-year program. We hold this ratio to be a proper one, the remaining hours to be devoted to scientific engineering and cultural subjects. Although the cultural subjects have shown a proper tendency to increase during the past few years, the scientific and engineering subjects properly, as we see it, preponderate in total over those dealing with economics and business.

Trends in the Subject Sequence

We have held that the only justification for a course curriculum in our department, in place of a group of electives or service subjects, lies in the principle that administration is a process of synthesis as well as analysis, and that the administrator must, therefore, be versed in the fundamentals of a completed round of the more important industrial functions.

Our curriculum, therefore, incorporates a required minimum of study in the areas of economics, management methods (including statistics, report writing, time study and work simplification and the like), finance, law, marketing, production, accounting, and labor.

In attempting to sequence and relate these required subjects over the period of three years we have pursued a normal amount of experimentation. Originally, the work began with study in the fields of economics and statistics, followed by accounting, with law, production, marketing and labor roughly in the order named. The final thesis served as the only coördinating instrument. Later we added a subject entitled "Industrial Problems" where a greater opportunity to introduce this synthetic factor became available. With the increasing rapidity of current economic change it was next decided to offer a course in current economic problems in the senior year, and more recently the elementary subjects in economics have been moved forward to the junior year permitting the students to begin their work with us in the field of production methods, this subject being transferred to the sophomore year.

May I visualize these changes in another way? I like to think of our business and economic subjects as following the contour of a ship, the introductory or bow-subjects, having to do with produc-

tion and statistics, each of which relates readily with previous work in engineering and mathematics. The mid-section subjects are the functional presentations of finance, law, production, marketing, accounting and labor, while the stern-subjects (industrial problems, and thesis) are essentially coördinative in nature. You will note that I have omitted economics from this analogy. I enjoy thinking of this area as representing the water upon which the vessel moves; and this brings me to a future and yet unsolved problem. It is clear that administrative navigation must concern itself with sociological and governmental as well as economic tide and current. How to underlay our present curriculum with these added components is a deeply puzzling question. As one of my senior professors has aptly put it, "It is the old difficulty of getting three pints into a quart."

Trends in Coördination

I should quickly say that the course has, from its beginning, been blessed with a readiness on the part of other departments to coördinate their work with its needs. A line of demarcation between subjects to be classified in the department of economics and social science, rather than in our department, was easily determined upon. We have always arranged that the engineering and scientific components in our program meet the full approval of the heads of the respective departments as to professional content. In general, the technical subjects taken by our students do not carry into the advanced areas of design but they do comprise a full quota of fundamental and intermediate subjects necessary to professional competency. Finally, during the past several years we have been working in conjunction with special faculty committees to facilitate the possibility of student transfer from one course to another during the sophomore year and to meet certain general requirements in point of total number of subjects per term and other desiderata.

Recently, we have effected two groups of coordinations which appear to hold considerable promise. The work of the English department, beginning as it does in the freshman year, has now been so coördinated with classroom work in our functional subjects through the medium of report writing and a special English consultation service, offered to our students, that standards developed in the earlier years are made habitual and normal in subsequent reports and thesis work. Again, a new program of electives to be later described, permits a coördination of thesis research with previous elective subjects in a way which should have a particularly strong appeal to the individual interest of the student. In general, we feel that we have achieved a certain coördination in

our approach to a field of education where exceptional variety in subject matter is not only inherent, but desirable.

A future problem looms large. With the growing emphasis throughout education upon the adjustment of curriculum to meet the individual requirements and interests of the students, we face the perennial difficulty of conflict in recitation hours. Until recently our course gave students opportunity to choose their technical field in the civil, the mechanical, the industrial or the chemical option. For the coming year this choice has been reduced to either the physical or the chemical sciences. In short, we are neutralizing the problem rising out of the increasing complexity of engineering activity, by withdrawing into more basic and general areas. To compensate for this trend toward fundamentalism in science and engineering, we are introducing wider latitudes of specific choice in business and economic subjects. Hitherto, each of the functional requirements such as marketing, production, finance, have included a double term of work. Now, only the first term is required, the second being optional, the number of these options being considerably increased over previous second-term offerings. Thus the student may concentrate within the area of his special interest during his senior year without eliminating the proviso that he develop a facility in dealing with each of the important functional areas of management. Yet we are not sure that we have done enough to satisfy the individual interest and proclivities of the student. The question fascinates us.

Trends toward Greater Realism

More and more it is being borne in upon us that the environment of industry is essentially a strange one. Young people have seen the walls, have used the product, but frequently they know little about the "innards" of either.

Over the past several years, we have been laying increasingly greater emphasis upon our plant visitations. Discarding the more formal group tours of larger establishments in the senior year, we have prevailed upon something over 125 smaller coöperating companies to extend their hospitality to groups of not more than four students who, under the leadership of a student chairman, undertake their own visitations and prepare their reports. In coming years the use of this device is to be extended into the sophomore year, and also will be widened to incorporate conferences with sales, financial and accounting executives as well. With these industrial contacts as early in our curriculum as possible we are in process of extending the use of small dinner conferences at which a limited number of students spend the evening with an executive to discuss

informally with him current industrial situations and problems. A series of weekly discussion meetings of this nature for a special group of graduate students of maturity and industrial experience proved so salutary that the device has been extended to monthly meetings of the same sort for all graduate students, and last year similar annual conferences were arranged for seniors.

A third implement is the use of the case method on the part of the various members of the staff. Some subjects yield to this procedure more readily than do others and we make no effort to stress the acceptance of this medium by our teachers. Nevertheless, it does bring a quality of realism and a freshness to discussion which is gratifying to the instructor. There is little doubt that the thinking potential can be raised to high degree through such a measure.

Further, we have cleared our summer periods as far as possible of required classroom or laboratory work and are now laying stress upon industrial experience gained during these interims. An industrial tour of Europe has also been carried on for five summers in which a considerable number of students have participated.

Finally, it has long been a prerequisite that teachers in our department shall be men of practical experience in their respective fields. This prerequisite has brought into the classroom a quality of reality for which there seems to be no substitute.

Here again we have a problem before us. Of the infinity of industrial realities, which are the most important for these young men to experience? A realistic experience which stresses contemporary problems may not prove representative over future periods; that which stresses administrative activities may find application too far in the future to be practical; that which stresses industrial operation or processing technique may prove too specialized and lacking in stimulation toward higher responsibilities. Again, it is a knotty question, and to say that all these types of experience should be indulged in to the full is to laugh in the face of the clock.

There are doubtless many other trends of which you would have preferred that I speak, and of these that I have mentioned I know you would have preferred to hear me cry "Eureka, I have found it" and produce some eternal verity which would solve each problem once and for all.

This I wish that I might do, but I cannot. In partial explanation may I submit the little verse:

> Trends make me think of jaguars
> That roam uphill—down dale
> But quite unlike these beasties
> Trends have no heads or tails.

A FLOATING CURRICULUM FOR ENGINEERS

By EDMUND D. AYRES

Associate Professor of Engineering Economics
University of Wisconsin

As the result of a two year study at the University of Wisconsin undertaken in the effort to answer the question as to what should be done at Wisconsin with respect to the teaching of business and economics to engineers, an idea was evolved whose soundness and simplicity makes it worthy of consideration for application on a national scale.

Fundamental Premises

In considering a plan for providing education for the engineer in business and economics, at least four definite fundamental premises are immediately encountered:

(1) In the usual four years' college preparation, it is impossible to expect the average engineering student to emerge with a degree in engineering and also a degree from a school of commerce.

(2) Engineering schools are primarily interested in turning out men with the proper background for becoming successful engineers, hence it is of first importance that the engineering student in college emerge at graduation with an adequate education in engineering fundamentals.

(3) The present trend toward professionalism in engineering is not likely to diminish in importance in the coming years, and the old importance of graduation from an engineering school as the end of one of the final stages in an engineer's preparation is overshadowed, or soon will be, by goals pushed forward to several years after graduation in the form of a state license or recognition of an attainment of a professional level by engineering societies.

(4) The engineer has a definite need for an education in business and economics, ranging from the needs of an ordinary citizen to the needs of a future executive or administrator in industry. In attempting to meet the needs of engineers within such a wide range, any plan for education in these fields must have sufficient variation in the way of optional paths to meet the particular demands and problems of the individual engineer.

Lengthening the Engineering Curriculum

Many interviews with prominent engineers and engineering educators over the period given to this study have revealed a growing conviction that courses in engineering must be lengthened to five or even six years. Ultimately it may be feasible to so lengthen the period of resident instruction. There is, however, a definite draw-back to such proposals. Today there are many capable engineering students who are finding even the term of four years a severe drain upon their economic resources. It does not seem possible that the idea of lengthening the curriculum can ever be universally adopted in the face of this one real obstacle. The careful development of post-graduate and post-scholastic work by the universities, however, can sidestep this obstacle, gain the lengthened curriculum in fact, and moreover provide the instruction at a time when it can be thrown against a background of the junior engineer's work in industry. Thus the work can be given to the engineer in the realistic atmosphere and environment of industry, which for certain purposes is likely to prove more stimulating and conducive to its appreciation than the college environment.

The Floating Curriculum Idea

The idea which has been proposed for consideration at the University of Wisconsin recognizes the two limits:

(1) The matriculation of an engineer as a freshman in the engineering college, and
(2) professional recognition coming probably several years after college,

as the two points in time within which the plan should normally operate. It proposes an organized path with many options to be made available:

(1) in the form of resident instruction at the University of Wisconsin,
(2) in the form of correspondence instruction through the University of Wisconsin Extension Division, and
(3) in the form of class instruction through the Extension Division of the University of Wisconsin at Milwaukee.

It proposes:

(1) that this plan be called to the attention of students in their freshman year in college,
(2) that as much of the work as their individual programs and interests will permit be offered, with the proper amount of

guidance in these matters, to undergraduates and graduates in residence in the form of regular college courses, and

(3) that any part of the work not taken in college or all of the work, if so desired, be offered in the form of correspondence instruction or class instruction at the Milwaukee Center of the University of Wisconsin Extension Division.

It further proposes that for a definite amount of the work satisfactorily completed by attendance at College, a degree of Master of Engineering and Economics be offered (provided satisfactory arrangements can be made with the Department of Economics in the School of Letters and Science); also for completion of the work, partly covered by correspondence and partly by resident instruction at the University of Wisconsin, or entirely by correspondence instruction, that a certificate indicating a completion of the course be granted.

Course Content Subject to Wide Variation

Such a proposal provides the flexibility which is essential to meet the varying needs of individual students both with respect to course content and availability of facilities to obtain instruction when and where needed.

The matter of course content or subject matter to be offered is open to ready change and infinite variation. It is believed that in addition to business studies as listed below, the door is wide open for the inclusion of better treatments of such subjects as engineering English and public speaking, the treatment of advanced technical work and any amount of cultural work in the humanities.

What Are Business Studies?

The study to date has attempted a focus upon what the author has chosen to call "business studies." The view taken was this. The engineer in general is called upon to work for or with business units already established, the corporation and the giant corporation probably looming over all other types in importance. One of his first and most practical needs is for more technical familiarity with the inner workings and administration of these units in order that he may orient his own work properly with other functions of the business that are non-engineering and in most cases financial in character, and that he may develop to its highest level any innate ability he may have to lead others and get along with others in his sphere of influence. Not second in actual importance, but perhaps second in practical importance, he should have a view of social matters to help him understand the significance of his work and that of others in order that he may be ever ready intelligently to join

forces with or stand firm against those social movements which are intended by others to improve society as a whole. The following list of business studies is aimed primarily to furnish the technical familiarity cited first and lay certain foundations for cultural work which may be needed for the latter aim. The following list is not exhaustive, it simply represents an honest attempt to compile a list of studies with which the engineer should have a working familiarity in the main:*

1. Economic Theory
2. Accounting
   - *a.* Bookkeeping Methods
   - *b.* Financial Statements
3. Statistical Theory
4. Economic Selection and Replacement
   - *a.* Arithmetic of Economic Selection
   - *b.* Estimating
   - *c.* Depreciation
   - *d.* Plant Location and Layout
   - *e.* Specifications for Materials and Machines
   - *f.* Economic Lot Sizes
5. Business Law
   - *a.* Contracts, Torts, Bailments, Agencies, Carriers, Sales, Negotiable Instruments, Bankruptcy, Suretyship, and Guaranty
   - *b.* Law of Corporations, Partnerships, and other Business Units
   - *c.* Public Utility Law and Government Regulation of Industry
   - *d.* Patent Law
6. Marketing and Merchandising
   - *a.* Market Analysis
   - *b.* Salesmanship
   - *c.* Sales Management
   - *d.* Advertising
   - *e.* Prices
   - *f.* Purchasing
   - *g.* Transportation and Traffic Management
   - *h.* Cooperative Marketing
   - *i.* Foreign Trade

* This list was first submitted in a report to Dean Turneaure of the College of Engineering dated September 30, 1935, entitled "An Engineering Economics Department of Instruction for College of Engineering."

7. Labor and Personnel Management
    - *a.* Human Relations and Applied Psychology in Handling Men
    - *b.* Principles of Efficiency
    - *c.* Incentive Systems
    - *d.* Time and Motion Study
    - *e.* Personnel Surveys
    - *f.* Job Specifications
    - *g.* The Labor Market
    - *h.* Trade Unions
8. Money and Banking
9. Business Organization
10. Corporation Finance
11. Corporate Consolidations and Reorganizations
12. Financial and Business Forecasting
    - *a.* Business Cycles
    - *b.* Statistical Analysis
    - *c.* Budgetary Control
13. Organization for Operation
    - *a.* Organization Charts
    - *b.* Planning, Scheduling and Dispatching
    - *c.* Operation of Stores
    - *d.* Quality Control
14. Cost Finding
15. Valuation
    - *a.* Basic Principles
    - *b.* Cost and Value Determination
    - *c.* Depreciation Theory and Practice
    - *d.* Law
16. Investment and Speculation
    - *a.* Financial Arithmetic
    - *b.* Risk and Profit
    - *c.* Stock and Produce Exchanges
17. Insurance
18. Real Estate
19. Credits and Collections
20. Government Finance
21. International Exchange

Out of this list were chosen:

(*a*) economics
(*b*) accounting
(*c*) statistics
(*d*) business law
(*e*) economic selection and replacement, and
(*f*) marketing and merchandising

as fundamental introductory studies which should be covered in laying the foundation for an individual plan.

Growing out of and closely related to these introductory studies is another group of studies, a large proportion of which should be fitted into any plan. In the report mentioned above, the following subjects were selected:

(*a*) business organization
(*b*) corporation finance
(*c*) money and banking
(*d*) labor and personnel management
(*e*) business forecasting
(*f*) government finance
(*g*) investment and speculation
(*h*) insurance, and
(*i*) international exchange

Beyond the subjects mentioned above, including the fundamental introductory subjects, lie many special emphasis groups into which individual interest and a particular professional experience will lead both early and late in the programs of various individuals.

Place of Orientation Courses in the Floating Curriculum

As to the relation of orientation courses to the work, in a speech given before the Graduate Study Conference, held in connection with the annual meeting of the Society for the Promotion of Engineering Education at Madison last June,* the author outlined briefly his opinion as to the proper handling of this matter. The present survey courses at Wisconsin are deemed admirably suited for use as orientation courses. They are built around the subjects of "accounting for engineers" and "economic selection and replacement" as key material. The treatment of either of these subjects by other than an engineer leaves something to be desired which it is hard for a differently trained teacher to meet.

The matter of accounting should be treated from the engineer's viewpoint of the use of accounting as a methodology or tool, with the specific purpose of covering the accounting field very quickly,

* Page 103, Journal of Engineering Education, October, 1936.

yet with sufficient thoroughness to give an engineer with no previous background a grasp of the subject such

(1) that he can, with confidence, find and interpret accounting information which he may have cause to obtain directly in the books of any business in his engineering work, and
(2) that he can carry on a conversation with a professional accountant in a business conference with full understanding of the meaning of the many accounting terms and with an insight into the purposes, limitations and advantages in the use of any particular double entry system, ranging from a simple set of books to one employing many subsidiary journals and ledgers and embracing many special features.

The subject of economic selection and replacement pertains largely to the "will it pay?" problem and deals specifically with the selection and replacement of equipment, the preparation of estimates and certain major aspects of valuation.

Using these two subjects, namely accounting and economic selection and replacement as vehicles for an orientation course, it is possible to present extremely important material, while, at the same time, a glimpse down the various paths of study leading out from engineering into business and economics can be given from particularly favorable vantage points. It is believed that, in the orientation course so constructed, it is possible to cover the average needs of the engineer in these particular subjects. To make this point particularly clear, I wish to state that intensive preparation for certain executive and administrative work in all probability would require some engineers to take further training in accounting taught from the accountant's viewpoint rather than from that of the engineer. The intention, however, is to cover the two fundamental introductory subjects of accounting and economic selection successfully within the bounds of such an orientation course.

Future Possibilities for the Floating Curriculum

The big job is not done, however, once the program for resident instruction and post-school instruction of business studies is operative. The inviting opportunity of the university is only niggardly realized if the plan is pushed no farther. If the engineer is to be built up professionally with attention to engineering English, advanced technical work, cooperation with state licensing boards and, as is fondly hoped, with considerable attention to developing the stature of the individual and improving the ethics of the profession, this is a task for the engineering college with as much partnership with industry as can be worked out. Lest this vision

be an additional scarehead for the engineering educator, who of all men, is prone to keep his feet on the ground, with haste it should be stated that this vision is the star to which his hopes and aims should be hitched—the building of the ladder into this stratosphere must come with sound and careful measures to insure the success of such an ultimate venture. It is believed that the College of Engineering can start with a modest program of handling business and economics for the engineer and build outwards into the post-school area and inwards into the resident instruction area now comprising its own bailiwick.

Digressing slightly from the subject in hand perhaps, it nevertheless seems appropriate to point out that just as economists, sociologists and other social scientists have their opposing schools of thought—so has the engineering educator in the matter of treating the subject of how to meet the need of the engineer for the greater opportunity in the field of business and economics. We find one school of men who firmly believe that the strict scientific and technical path in engineering is the best preparation for almost any path of life. We have another, the extremists among whom advocate the abolishment of both engineering schools and schools of commerce in favor of "schools of industry." Because both of these ideas are definitely needed to provide the kind of an engineering education which will fit the broad range of candidate aptitudes, modern engineering education is doing both. Side by side the eminently technical curriculum is being paralleled with curricula leading to administrative degrees and the like. Such a solution, however, in the opinion of the author, sidesteps the real need. The student with technical strength is neglected while something very definite is being done for the strongly commercial-minded engineering student. The student to be classified in between these two types is getting a "laissez faire" treatment which neither makes for building his stature technically nor commercially. Some day perhaps the engineering college will be organized like industry with a vice president in charge of production and a vice president in charge of purchasing and marketing. A dean will be used to assume the responsibility for quality of curriculum and standards of instruction as now. Still another dean coordinate in responsibility and importance will busy himself with the quality of the raw product coming to the engineering college from the high schools, the development of the personality and professional strength of the students in the educational process, and the marketing of the finished engineering product to industry, and if the proposal made here bears fruit, with the guidance and development of the product leaving the college through the junior engineer period to a mature professional level.

Criticism of the Idea

Immediately upon completion of the study early in March 1937, about ninety copies were sent out to a relatively small but important sample group of educators and engineers. Among this group were many who had followed the two years of studies and by suggestion and comment had contributed in that way to the final conclusions stated in the paper. This narrow but important circle of men have been of inestimable assistance in these studies, furnishing not only important suggestions and hard hitting criticism but also laying a foundation of confidence in the soundness and importance of the ideas advanced. Returns from this source for criticism were particularly encouraging—the amount of favorable comment and even enthusiasm for the ideas expressed in the paper was particularly satisfying. In the adverse criticism received, however, several points have been stressed which are of major significance. These points might be listed as follows:

(1) Too comprehensive.
(2) Plan is beautiful in the abstract, but lacks concrete detail as to how and where to begin.
(3) University extension correspondence work lacks the teaching quality necessary for the success of the plan.
(4) Marketing problem acute—engineer interest can only be stimulated with great effort if at all; engineer interest, if stimulated, can not be held; ambitious engineer will dig out his needs for himself—extension work will offer little help.
(5) The educating of the engineer in business and economics should be left to industry.

Comprehensiveness as a Fault

The inclusion of such a list of business studies as appears above with the suggestion that avenues be left open for additions to this list of cultural and advanced technical subjects is so staggering that the reader is inclined to become lost in its implications and stamp the plan as having no dimensions, no focus, and therefore no starting point. If this be a weakness, the actual operation of the plan must rise above it, for the wave of a wand will not make the list disappear, nor is there any question that the above work, without additions, represents a life-time task if tackled by the student under his own power by selections of his own from the downtown bookstore.

The plan in the face of criticism of its comprehensiveness settles down to this simple procedure. A curriculum requiring definitely

the six fundamental subjects listed above, further requiring an election of, say, four from the second list of "closely related subjects," and in addition, say, six more subjects from the entire list could not be considered unwieldly in the face of a comparison with any one of the highly developed programs leading to administrative, industrial engineering on business and engineering administration degrees in many of our colleges. The plan then consists of a curriculum of six required studies, four restricted electives, and six free electives. Such a plan can be operated by means of orientation courses covering accounting and economic selection and replacement taught by engineers and courses representing the remaining list of subjects taught by economists, sociologists and other experts in whose fields the subjects lie. This course can float between the end points given of matriculation in college and the day of achievement of a recognized professional level using resident instruction, extension work centers and correspondence instruction with but the small teaching contribution mentioned and little other than a strong coordinating influence emanating from the engineering college. That is absolutely all there is to it. To improve it may require the simplification and condensation of many subjects, to enrich it may require the association of other features, but the starting curriculum suggested is within the reach of almost any college without much change in course content for subjects now being taught. The ideas as a whole once instituted, the difficulties arising from so many professions attempting to work together can be ironed out with leisure.

Lack of Concrete Plan for Installation

Post graduate work in business and combination courses between schools of engineering and business administration are concrete samples of the working of the resident instruction ideas formulated. Night school work for the employed engineer in large cities such as New York and Chicago are concrete examples of the working of the extension center ideas formulated. Work of such correspondence schools as the Alexander Hamilton Institute and La Salle Extension Institute are concrete samples of the working of the correspondence ideas formulated.

At Wisconsin first should come a market analysis, second a formulation of course material, third a selection of instructors, fourth proper advertising, fifth the launching of the project. Through all steps and continuing as a process should be felt the interested hand of the College of Engineering in correlating and improving the work and its scope. The details of the plan anywhere will remain in the abstract until those affected by the plan

indicate what part they will or will not be willing to play in its promotion and execution.

Comprehensiveness of the proposals and indefiniteness of objectives are considered as the chief miscreants in introducing difficulties in arriving at a concrete approach to a start in the work. There has to be a compromise between the idea of serving each engineer's case as an individual one and the practical organization of teaching facilities. For the needs of the engineer the detail type of teaching to be found in the commerce school may require considerable modification because of the time element involved—extreme condensations of subject matter may be permissable and even desirable.

Quality of Extension Teaching by the Universities

The exceedingly capable Dean Holt of the Wisconsin Extension Division feels very strongly that Wisconsin has definitely overcome quality of instruction difficulties in correspondence work by operating upon the philosophy that Wisconsin in correspondence work "sells teaching" and not "books." The author firmly believes one will find little support for attacks upon the quality of instruction in Wisconsin extension correspondence work.

Marketing Problem

The work will only appeal to the ambitious engineer. The field is too huge and broad to be successfully dug out by the ambitious engineer alone on his own power in a time that can be considered a reasonable one. Stimulation of graduate engineer interest must come from their work and personal ambitions—these lacking, the value of any further stimulus is of questionable effectiveness. A market analysis is of prime importance and will pretty definitely settle contentions.

Leaving the Job to Industry

Large industry is doing a very fine job in the field. Without a careful survey of their work it would seem possible to draw the offhand conclusion that a great deal can be left to them. On the other hand certain fundamentals should be taught * in school even for the candidates for jobs in large industry. Not all engineers, of course, find their employment in large industries.

* See "A Suggested Course on Industrial Economics and Business Methods" by R. E. Hellmund, Chief Engineer, Westinghouse Electric and Mfg. Co., p. 446, *Electrical Engineering*, April 1937.

Adoption of the Floating Curriculum Plan Seems Inevitable

Whether the idea of a floating curriculum meets with the approval of the University of Wisconsin or not, whether the Engineers' Council for Professional Development can see in this plan a sound "going concern" plan for adoption for its professional training needs or not, whether the engineering societies and industry can approve the extension of the influence of the university into the post school field or not—the problem will remain and ultimately a plan of the nature suggested seems inevitable as the next step in engineering education.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The work of the Engineers' Council for Professional Development in connection with the accrediting of engineering colleges naturally led to the accumulation of a large amount of data and information concerning the engineering colleges of the United States. It was suggested by a number of the members of this Society that this information might be made into a study of the engineering colleges provided funds could be secured to analyze the material properly. The Secretary presented this matter to the Chairman of the Committee on Engineering Schools of E. C. P. D. This Committee had already considered the matter and through the Chairman of E. C. P. D. was trying to secure funds.

Charles F. Scott, Chairman of E. C. P. D., has just announced the gift of $10,000.00 from the Carnegie Corporation through the Carnegie Foundation for the Advancement of Teaching, for a report on the status and trends in engineering education in 1937. This is the culmination of the activities in prospect of the Committee on Engineering Schools as outlined in the Fifth Annual Report which has just been issued.

MECHANICAL ENGINEERING COURSES FOR NON-MECHANICAL ENGINEERING STUDENTS *

By VENTON L. DOUGHTIE

Professor of Mechanical Engineering, Texas Technological College

The author, realizing the many opinions on the proper courses to be pursued in obtaining an engineering education, believed that a paper on the subject of "Mechanical Engineering for Non-Mechanical Engineering Students" would be worth more to the group if the curricula of various colleges and universities were studied in order to obtain some basis for discussion. So this paper will give the mechanical engineering courses taught non-mechanical engineering students in a representative number of colleges and universities; the average for this group; the apparent trend; and finally the author will outline the mechanical engineering courses which he believes should be included in other engineering curricula.

The author found as reported in the "Investigation of Engineering Education," under the auspices of the S. P. E. E. that some changes in the curricula of certain colleges have taken place. This verifies such statements as "Our curricula were revised. . . ." "All of the engineering curricula have been revised to approach the recommendation of the S. P. E. E. committee on Investigation and Coördination." Page 1172–1173. Twenty-six colleges were chosen for the study, five in the Southwest, six in the South, three in the North, two in the East, five in the West and five in the Middle West. By the selection of this group it was hoped to obtain a cross section of opinion throughout the United States and to show the variation of opinions. They were not chosen in order to prove any one thing. No attempt was made to classify the school as to academic standing or enrollment. An effort was made to reduce the various courses to the semester hour basis. However in some instances only an estimate could be obtained. All information was gleaned from the latest available catalogues, 1936–37 in most cases, but never earlier than 1934–35.

Before reviewing these findings it might be well to attempt to define mechanical engineering courses since the subjects taught in the mechanical engineering department vary with different schools. In fact it was found that there were only three mechanical engineer-

* Presented at a meeting of the Texas Section, S. P. E. E., at Dallas, April 30, 1937.

ing subjects for non-mechanical engineering students taught consistently in the mechanical engineering department; namely, heat engines, mechanical engineering laboratory, and machine design. However it was found that machine design was taught in the mechanics department in one school, not included in this survey. Thermodynamics may be taught in the chemical engineering department; heat in the physics department; shop in the industrial engineering department or shop department; mechanism or kinematics in the drawing department; strength of materials, materials of engineering and mechanics in various departments; and hydraulics, labeled as such and under such names as hydraulic machinery, pumping machinery and fluid mechanics in the civil engineering department, mechanical engineering department or theoretical and applied mechanics department. Then there are courses in engineering problems taught in the mechanical engineering department, engineering problems department and general engineering department. Apparently the department in which a subject is taught depends upon local conditions which are not easily changed and probably should not be changed. As the school grew certain departments developed new courses and other departments which probably should have taught the subject were either overloaded, lacked man power or perhaps needed alert personnel. In some cases a certain department had a man who ranked high in some particular field and developed courses which were desirable for all engineers. Often the administration dictates the course and the department to teach it. The size and financial support of the school are also to be considered.

The author believes that courses under the head of shop, heat, and design should be taught in the mechanical engineering department for non-mechanical engineering students and used this as a basis of study. Shop includes such courses as woodwork, pattern making, foundry, forge shop, machine shop, heat treating, metallurgy, welding practice, and sheet metal work. Heat covers not only those courses labeled heat engines but thermodynamics, power plants, heating, air conditioning, heat transfer, internal combustion engines, refrigeration, and mechanical engineering laboratory. Design includes such courses as mechanism or kinematics, dynamics of machinery and machine design. Mechanical engineering courses for non-mechanical engineering students were studied for architectural engineering students, chemical engineering students, civil engineering students, and electrical engineering students. Straight architecture courses were not reviewed. Textile engineering and geological engineering or petroleum production engineering were not studied because these courses are in only a comparatively few schools and time did not permit. Some of the peculiarities in the curricula of the various institutions are noted under "Remarks."

Now let us briefly study the findings in order to determine the general trend.

Architectural Engineering.—One school required a two-hour course in shop. This course is a special course in sheet metal work. Courses in heat vary from 0 to 9 hours with an average of 2.96 hours. Design courses vary from 0 to 6 hours but in the 6 hour case, the design is a structural design course. So it seems as if a course in heat is the only necessary mechanical engineering course for architectural engineering students.

Chemical Engineering.—Shop courses vary from 0 to 4 hours with an average of 0.82 hours. The shop courses offered are either elementary for the purpose of teaching the student the use of hand tools and some machine tools or of an advanced nature such as metallurgy or heat treating. Courses in heat vary from 0 to 9 hours with an average of 4.78 hours. Design courses range from 0 to 8.7 hours with the majority offering no design at all. It should be noted that the school which offers 8.7 hours requires regular mechanical engineering design courses, which include mechanism, and the design of machine parts. It should be pointed out that chemical engineering in its infancy was often given as a mechanical engineering-chemical engineering option and, in some instances, is still in the Mechanical Engineering Department.

Civil Engineering.—Courses in shop vary from 0 to 2 hours with the majority requiring no shop. Heat courses range from 0 to 8 hours with an average of 3.58 hours. The time for design varies from 0 to 4 hours with only a few schools requiring any design. The design courses required are usually mechanism.

Electrical Engineering.—Courses in shop vary from 0 to 7 hours with an average of 2.63 hours. Heat courses range from 4 to 14 hours with all schools requiring at least 4 hours. The average is 8.6 hours. Design courses, which do not include electrical design but only those dealing with mechanism, dynamics of machinery and design of machine parts, vary from 0 to 8 hours with an average of 2.97 hours. Some schools do not require any design at all.

Special Courses. The Wickenden Report very definitely recommended the teaching of fundamentals and fewer specialized courses. Some extracts from this report might be beneficial. Page 148. ". . . we believe that the largest group of advantages, under ordinary conditions, may be secured through progressive concentration of effort in three stages: (1) an undifferentiated period of at least one year; (2) a period of moderate differentiation centering on basic groups of sciences such as physics and mechanics, physics and electrodynamics, physics and chemistry, physics, chemistry and geology, etc., which underlie the major branches of engineering; and (3) a final period of greater concentration in group options which

aim at a cumulative rather than a scattering result." Page 393. "The thought most often expressed and strongly emphasized, particularly by the engineers, is that specialization is out of place in undergraduate curricula and that thorough grounding in fundamentals is of paramount importance." Page 413. "In the entire body of opinions cited and analyzed in this bulletin there is discernible a fairly consistent conception of what engineering curricula should be. 1. Moderate diversity, but tending away from specialization; 2. Dominance of scientific and broadly technical content and emphasis; 3. Inclusion of a well-identified core of required subject matter in common; . . . 7. Thoroughness rather than completeness of detail." In the study made the courses in heat for architectural engineers in most cases were special courses dealing with mechanical equipment of buildings from a practical standpoint. In only a few cases were elementary thermodynamics studied. For chemical engineers 10 out of the 22 schools, which require courses in heat, give special courses for either chemical engineers alone or for all non-mechanical engineering students. In civil engineering, 9 out of the 21 schools requiring heat courses give special courses. Electrical engineering students study seven specialized courses in heat, two in shop, and five in design. From this survey it is apparent that special courses are taught for all departments but that the electrical engineering students more often study the regular mechanical engineering courses.

In summing up the survey, one would conclude that the general trend of the courses required in mechanical engineering for non-mechanical engineering students are: (1) 4 hours of special courses in heat for architectural engineers; (2) 5 hours of special courses in heat for chemical engineers; (3) 4 hours of special courses in heat for civil engineers; (4) 3 hours of regular shop; 9 hours of regular heat and 4 hours of regular design for electrical engineers. The four-hour course in heat for architectural engineers is usually labeled mechanical equipment of buildings and includes elementary thermodynamics, fuels, properties of steam, hygrometry, small boilers and auxiliaries, pumps, heating and ventilation. The five-hour heat course for chemical engineers in most cases is thermodynamics. The four-hour course in heat for civil engineers is usually called heat engines and covers elementary thermodynamics, combustion and fuels, boilers, steam engines, internal combustion engines, condensers, pumps and turbines. Often a one-hour laboratory course is included in which the student tests and calibrates instruments used in testing power equipment and runs elementary tests on an engine, a boiler, a pump and perhaps a fan. The three-hour course in shop for electrical engineering students consists of pattern shop, foundry, and machine shop. The nine-hour heat course includes

thermodynamics, power plants, and a two-hour laboratory course. The four-hour course in design is usually in mechanism.

In conclusion, may the author suggest for discussion the mechanical engineering courses which would be desirable for non-mechanical engineering students? There is only one curriculum studied, architectural engineering, for which a special course in mechanical engineering should be given. This should be a special four-hour course in heat covering elementary thermodynamic principles, and mechanical equipment of buildings. This course should be of a practical nature and not theoretical. By this is meant that only

M.E. Courses for Non-M.E. Students in Semester-Hours

School	A.E.			Ch.E.			C.E.			E.E.		
	Shop	Heat	Design	Shop	Heat	Design	Shop	Heat	Design	Shop	Heat	Design
Rice	—	—	—		8			8	[a]3.3	7	8	[a]3.3
S. M. U.	—	—	—		8			3			10.5	3.6
Texas A. & M.		3			9			[a]3		2	[b]8	
Texas Tech.		6		[c]3	[b]8			[a]6		4	[b]8	[d]3
Texas Univ.		3			[a]8			4		2	[a]8	8
Alabama Poly.	—	—	—		2		2			6	9	5
Georgia Tech.		2			[a]5		1	[a]6		1	[b]7.6	
Johns Hopkins	—	—	—		5			5			13	6
Louisiana State		9	[e]6		4		0	0	0	1.5	9	3
North Carolina	[a]2			3.3	4		[b]2	2		[b]2	8	
Tulane	—	—	—		8	[a]3		7		Same as M.E.		
Cornell	—	—	—	5 yr. option in M.E.				[a]3		2	14	[b]7
Lehigh	—	—	—		[a]3			[b]4			[a]8	
Univ. of Pittsburgh	—	—	—	1	[a]3		1	2		1	5	[b]4
M. I. T.		4	4		[b]3			[a]5	4	4	10	4
Yale	—	—	—		[e]6		0	0	0		9	
Stanford	Same 4 yr. course for all with 22 free electives and 16 restricted electives.											
Univ. of Cal.	0	0	0	0	0	0		3		2	9	2
Univ. of S. Cal.	0	0	0		3			3			7	[a]2
Univ. of Wash.		1.3		0.7	4	4		2		2	4	6
Univ. of Wyoming	—	—	—	—	—	—		7.3	2.7	4	10.7	4
Univ. of Illinois		5			[a]5			[b]3		6	[d]11	
Iowa State		3.3		4	[a]1.3		0	0	0	4	10	1.3
Ohio State		[e]4		[e]4	2.7	[b]8.7		[a]5.3		[e]4	[e]8	[a]6
Purdue	C.E. option				[a]7			[a]4		4	7	
Univ. of Mich.	—	—	—	2	4	3		4		2	5	3
Average		2.96		.82	4.78			3.58		2.63	8.6	2.97
General Trend		4			5			4		3	9	4

School	*Remarks*
Rice	[a] Kinematics in Dwg. Dept. Strength of Materials in C.E. Dept. and Mechanics in Math. Dept.
S. M. U.	Mechanics, Materials and Mechanism taught by various departmental instructors. Coöp. plan.
Texas A. & M.	Materials in C.E. Dept.; Mechanics in M.E. Dept. [a] Special course—no lab. [b] 4-hr. special course in Thermo.
Texas Tech.	[a] Special lab. [b] Special course. [c] Metallurgy. [d] Special course.
Texas Univ.	Materials and Mechanics in C.E. Dept. [a] 2-hr. special lab.
Alabama Poly.	Mechanics, Materials, and Hydraulics in M.E. Dept. Dept. of Machine Design and Dwg. Shop in Ind. Eng'r. No spec. courses.
Georgia Tech.	Materials and Mechanics in Mechanics Dept. Lab. in M.E. Dept. [a] Special course. [b] Special course. Non-coöp. plan.
Johns Hopkins	Strength of Materials theory in C.E. Dept., Mechanics and Materials and lab. in M.E. Dept. No special courses.
Louisiana State	Mechanics and Materials in Mech. Dept. but use other Dept. staff. [a] Structural Design in M.E. Dept.
North Carolina	Mechanics and Materials in C.E. Dept. [a] Special course. [b] Special course.
Tulane	Mechanics, Materials, Dwg., and Mechanism, in one dept. [a] Special course.
Cornell	Materials and Mechanics—C.E. Dept. for C.E., M.E. Dept. for M.E. and E.E. [a] Sp. course. Hydraulics in M.E. Dept. [b] Sp. course.
Lehigh	Materials in C.E. Dept.; Mechanics in M.E. Dept. [a] Special course for Ch.E. and C.E. [b] $a + 1$ lab. [c] Special course.
Univ. of Pittsburg	Materials in C.E. Dept.; Statics in C.E. Dept.; Kinetics and Dynamics in M.E. Dept. [a] Thermo. in Ch.E. Dept. [b] Sp. course.
M. I. T.	Materials for C.E. in C.E. Dept. Mechanics, Materials, and lab. in M.E. Dept. [a] Special course. [b] Special course.
Yale	Mechanics Dept. [a] Thermo. in Ch.E. Dept.
Stanford	Materials and Mechanics in C.E. Dept.
Univ. of Cal.	Materials in C.E. Dept. Mechanics in M.E. Dept. Dwg. in M.E. Dept. Hydraulics in both M.E. and C.E. Dept.
Univ. of S. Cal.	Materials and Mechanics in Gen. Eng. Dept. [a] Special course.
Univ. of Wash.	Materials in M.E. Dept. No special courses. Hydraulics and Mechanics in C.E. Dept.
Univ. of Wyoming	Materials and Mechanics in C.E. Dept. No special courses.
Univ. of Illinois	T. & A.M. Dept. Thermo. for Ch.E. in Ch.E. Dept. [a] Special course. [b] Special course. [d] Special course.
Iowa State	T. & A. M. Dept. Fluid Mechanics in M.E. Dept. Dwg. in M.E. except for C.E.'s. [a] Special course.
Ohio State	T. & A. M. Dept. Hyd. Machinery in M.E. Dept. [a] 5-yr. course. [s] Shop in Ind. Eng. Dept. [v] Reg. M. E. [c] Special for C.E. [e] Special for E.E.
Purdue	Materials in C.E. Dept. Mech. in App. Mech. Dept. [a] Special course for each department.
Univ. of Mich.	T. & A. M. Dept. Hydraulic Machinery and Pumping Machinery in M.E. Dept.

those fundamentals and practical applications which the architectural engineer might encounter should be studied. His field in engineering is limited and there is no apparent need of his studying heat cycles, steam engines, internal combustion engines, turbines and power plant equipment with which he will not come in contact.

The course offered as heat is fundamental and should be the same for all engineering students. It was brought out by the Wickenden Report (Page 398) that elements of thermodynamics was one of the subjects which should be required in all curricula. Since this is a basic course, there should be no difference in content for various students. The only question is the amount of time which can be allowed for the course. In our study the general trend shows 5 semester hours for the chemical engineering student. Professor E. E. Randolph, North Carolina State College, in the January 1937 S. P. E. E. JOURNAL OF ENGINEERING EDUCATION on Page 418, states that for chemical engineers "heat engines courses range from $4\frac{1}{2}$ to 12 term hours and that the mechanical engineering laboratory ranges from 1 to 6 hours." This would indicate a total of 6 semester hours for heat. Professor M. O. Fuller, Lehigh University, in a paper entitled "Comparative Study of Civil Engineering Curriculum" in the S. P. E. E. JOURNAL OF ENGINEERING EDUCATION for May 1936, gives as an average time for the study of mechanical engineering 2.94 per cent of the total semester hours. Based upon 144 semester hours for graduation this would give 4.23 semester hours. Professor A. H. Lovell, University of Michigan, in the August 1932 issue of *Electrical Engineering*, gives a paper on "Engineering Subjects in the College Program" in which he states that the heat power course for 33 colleges varies from 5 to 13 semester hours with an average of 8 hours. This last figure compares favorably with our figure of 8.6 hours. So a four-semester hour course in heat for all engineers except architectural engineers is advisable. No laboratory should be included but all the time should be spent in studying thermodynamic principles and their application to prime movers. The chemical engineering student would then have 2 semester hours for a laboratory course. This course should include fuels and lubricants laboratory, and power plant equipment testing. The electrical engineering student needs 10 hours of heat. Besides the 4 hours of heat engines and the 2 hour laboratory mentioned above, he should have 4 hours for power plants which would include power plant design as well as equipment. Since the electrical engineering student will likely become connected with manufacturing industries of some nature it is believed that he should have at least a three-hour shop course which would cover pattern making, foundry and machine shop. The author is of the opinion that 4 hours in design is not sufficient for the electrical engineering student.

This course should be at least 6 hours, preferably 7. The regular course in mechanism for mechanical engineering students should be given to electrical engineering students. This course requires 3 or 4 hours. Then this course in mechanism should be followed by a three-hour course in the design of machine parts. Drawing should be minimized or eliminated entirely and the course apply the principles of mechanism, mechanics, and materials in the solution of many design problems. The author agrees with Professor R. H. G. Edmonds, University of Washington, who states in the March 1933 issue of the S. P. E. E. JOURNAL OF ENGINEERING EDUCATION, Page 532, that "There are three reasons why machine design should be considered as a fundamental and basic course and be required of the non-mechanical engineering student as well as the one majoring in mechanical engineering. First, the facts and information presented in such a course are desirable for all engineers. Second, the course in machine design provides instruction and experience in constructive planning. Third, machine design provides excellent mental training." To these reasons might be added that machine design offers an excellent opportunity for applying most of the principles studied in other courses. In summing up these ideas, the author suggests a four-hour course in heat for chemical, civil, electrical and mechanical engineering students; a two-hour heat laboratory course for chemical, electrical and mechanical engineering students; a three-hour shop course for electrical and mechanical engineering students; a four-hour course in power plants for electrical and mechanical engineering students; a four-hour course in mechanism for electrical and mechanical engineering students; and a three-hour course in machine design for electrical and mechanical engineering students. The mechanical engineering student will study more advanced courses in each of these three fields.

So in closing, may we suggest that in our crowded four-year curricula there be as few special courses for non-mechanical engineers as possible but that an attempt be made to give all engineers the same basic courses whether given in mechanical engineering, civil engineering, or electrical engineering. A statement in Rensselaer Polytechnic Institute catalogue sums up this idea: ". . . the Institute has learned that a student who has enjoyed a wide training in a major field is more likely to find an opening commensurate with his ability than is one who has specialized unduly."

Discussion

By FRANK M. SMITH, Associate Professor of Civil Engineering, North Texas Agricultural College

Professor Doughtie's excellent paper is based upon a statistical study of representative colleges, well distributed over the United States. His conclusions as to the time devoted to mechanical engineering subjects in non-mechanical engineering curricula, while based upon a study of only twenty-six schools, is in all probability representative of general practice over our nation. Further discussion of this portion of his paper would seem unnecessary. It seems that the discussion should be, as suggested in the paper, based upon the advisability of teaching special mechanical engineering courses for each major branch of engineering as compared with the teaching of basic courses applicable to all engineers.

If the plan of teaching basic courses is followed it will be necessary, of course, to augment them with special courses for some of the branches. Such a plan would be more economical of teaching costs by lowering the teacher's clock-hour load per student. This is a matter worthy of serious consideration in any institution. It is a very necessary consideration in the smaller schools. This plan would simplify the scheduling of students, especially in the sometimes troublesome case of the partial flunkee. The plan has the further advantage of throwing students of different branches of engineering into classes together. Your speaker feels that such an intermingling is beneficial to the students' perspective. It tends to prevent the development of departmental clannishness and an attitude of overspecialization. Often an instructor will give himself more fully to a section containing some students majoring in his own department than he will to a section containing only students whose major is in some other department.

On the other hand, where special courses are taught for students of different branches of engineering, the subject matter may be varied so as to prove more interesting to the particular group. While the subject matter should be very fundamental in its nature, it may be presented in terms of cases or problems which the particular group is more likely to encounter. Such a presentation would better intrigue the interest of the student and would help the instructor in selling his course to the group. As to whether this advantage would be utilized by the teacher would depend a great deal upon his versatility and personality, as well as upon his understanding of the principles of pedagogy.

In the opinion of your speaker this is a question which should be settled by each school in the consideration of its own circumstances.

After all, our prime objective is to help the student form habits of logical and analytical thought, and, at the same time, become familiar with fundamental principles. Different schools will no more accomplish this best in the same way than different teachers could do their best in presenting the same idea in exactly the same manner. While some standardization is undoubtedly highly desirable and we have at this time a nation-wide movement to standardize engineering education, we should guard against carrying standardization to an extreme. Each college should maintain its own individuality and character just as each instructor should maintain his own personality.

COMMITTEE ON ORIENTATION OF FRESHMEN

The personnel of the Committee on Orientation of Freshmen as listed in the year book is incomplete. It should be: A. R. Cullimore, *Chairman*, Paul Cloke, W. E. Duckering, H. B. Luther, F. Ellis Johnson, E. J. Streubel, Bradley Stoughton, B. R. Van Leer, and O. S. Zelner.

ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*

SOME OPINIONS OF ENGINEERS ON THE IMPORTANCE OF ENGLISH

The article by Mr. Charles F. Kettering on "The Importance of English to the Engineer in Industry," which was published in *English Notes* in January, 1937, was of so much interest to teachers of English in engineering schools that the editor decided to gather the opinions of other engineers on the subject. Therefore he invited a representative group of engineers to comment briefly on the query: "Is English of any real importance to the practicing engineer?"

The replies printed below need no explanation. They show that the members of the engineering profession regard English as an important subject in any program of studies leading to a degree. They also indicate that older members of the profession believe that a young engineer who has a ready command of language will have a better chance for success in his chosen field.

Before turning to the replies, the editor would like to thank all the engineers who answered his query. He believes that the suggestions contained in this article will be of great assistance to teachers of English in engineering schools.

"Engineers no longer work alone. They are part of an organization that moves at a rapid pace. From chief executive to office boy there is impatience with a poor talker or badly written report. We hire young engineers and put them to work on the assumption that they will become leaders in the organization and will contribute creative ideas to the business. Yet too frequently they fail to get anywhere. . And my observation leads me to believe that this is largely because they cannot speak or write well and lack the ease and culture that comes from a knowledge of the humanities. They are no abler in these respects than those associate workmen who have graduated from high school."—L. W. W. MORROW, General Manager, Fibre Products Division, Corning Glass Works.

"My personal belief is that a command of English, both written and oral, is of vital importance to any engineer. Engineering projects must be presented at some time or other to laymen and if they are not pre-

sented effectively they fail to arouse sufficient interest to be acted upon. Whether an engineer is trying to finance some vast engineering project or merely describing his work to a superior, simple and forceful presentation is required for favorable consideration.

"Technical students, as a rule, do not realize the importance of writing a good report or technical paper. Neither do they realize the necessity of speaking convincingly. Yet their careers are often determined by these faculties. They usually dodge literary subjects, as I did, and stagger under an additional load later on."—LUIS DE FLOREZ, Engineer, New York, N. Y., Member, A. S. M. E., S. A. E., Inst. P. T.

"A broad and liberal education and even a touch of classical work, has its value, professionally as well as in the making of the man. On reaching a certain stage in his professional career, other things being equal, that man who can best meet intelligent and cultured men on their own level secures the highest and best professional line of practice. Social qualities, intellectual ability, solid learning, are effective reinforcements of the business side of life.

"I might address you at length, setting forth my arguments for a comprehensive course in English, Grammar, and Composition, subjects which I consider essential, in that without mastering them the student is unable to properly and forcefully express his thoughts either orally or in reports."—L. K. SILLCOX, First Vice-President, New York Air Brake Co.

"The engineer today is more dependent than ever before on his ability to convey his thoughts to others clearly, convincingly and forcefully. Change in business habits and the remarkable extension of scope of engineering activities, which now penetrate into virtually all human affairs and touch all circles of men, place effective expression of thought in a position of primary importance. One may see marked superiority in engineering analysis lose in the race through lack of corresponding ability in expression. As the trend toward increased emphasis on effective expression still continues, it is well that the subject is receiving careful attention.

"Examination of many recent letters, manuscripts, specifications, engineering briefs and reports, leads the writer to the belief that their defects lie as much in lack of ability to think clearly as in specific lack of writing skill. One often finds an irritating disregard of direct and continuous thought sequence. Illogical grouping of statement and jumbled organization of the presentation as a whole are common. These are evidences of something more fundamental than mere inexpertness in writing. This failure to think clearly and consecutively is the source of the major faults found in technical writing." *—F. E. SCHMIDT, Editor, *Engineering News-Record.*

"The engineer is judged largely by his report. No matter how good his work may be, he cannot convince his superiors of the value of his

* Printed with the permission of Prof. M. I. Evinger, University of Nebraska.

recommendations if his report is bad. Poor report writing has interferred, therefore, with many an engineer's advancement."—J. BENNETT HILL, Manager, Development Division, Sun Oil Company.

"It is not merely desirable—indeed it is quite essential—that the engineer should be able sympathetically to read and to listen and to get the finer distinctions and implications even from people of narrow literacy, and that he should, as a matter of habit, express his own ideas clearly and concisely, with precision and at the same time attractively and persuasively. Without such facility he isolates himself, and his mental processes, be they ever so good, remain sterile.

"Much more could and should be said as to the importance of English to the engineer as a human being. Such considerations, it is suspected, would profoundly affect the character of instruction in English as a preparation for living."—JOHN C. PARKER, Vice-President, Consolidated Edison Co. of N. Y., Inc.

"I have been pounding the teaching profession of engineering for half a century on this subject and I am glad to know that they are awakening to the importance of English."—J. A. L. WADDELL, D.E., LL.D., Waddell & Hardesty, Consulting Engineers, New York, New York.

"The question of training in English for engineers has always been a difficult one. Those qualities of mind which make a man a good engineer are apt to make him impatient of any considerations which he regards as too abstract or not a direct means to an end. We find, therefore, only too often that students in engineering come to the University with an insufficient background of either general reading or facility in English and also with a definite tendency to shirk their courses in English.

"Not only in the case of graduate students, but also in the case of practically all men that I have employed in a strictly professional capacity, the difficulty has been the same . . . not one of these men could intelligently summarize his own work so that he could either give someone else a clear understanding of what he was doing or leave the record in such shape that his successors could continue the program intelligently from the point where he left off.

"It is true that some of this difficulty rises from an inability to handle the English language. By that I mean a too limited vocabulary and an inability to use words with precise significance, a lack of understanding of the common rules of grammar, and similar difficulties. I believe, however, that the greatest difficulty, which is ordinarily considered due to lack of training in English, is not that at all but a lack of training in logical thinking."—W. L. BADGER, Manager, Consulting Engr. Division, Dow Chemical Company, Ann Arbor, Michigan.

"A close friend of mine, who is vice-president of a large corporation, and who has had a great deal of contact with technical men, remarked one day that he would strongly recommend that courses in English be continued throughout the four years of the engineering college course. He felt it was quite essential to broaden the cultural interests of students taking specialized courses. In my own experience I recall members of

my university class who graduated with a fine understanding of engineering principles, but whose written and verbal reports were as illiterate and loosely worded as those of the average uneducated mechanic. It has been remarked that among college graduates generally, the engineers as a class have apparently less facility in expressing themselves clearly, probably due to the absorbing demands of the technical subjects during the college course, leaving little opportunity for attention to English.

"A sound education in the use of English both written and spoken, cannot be over emphasized in the training of engineers and technical men. The tendency in recent decades toward group rather than individual activities, emphasizes the importance of the ability to express ideas clearly, logically, briefly, and without ambiguity. The results obtained in technical research must be communicated through reports to the designing engineer and to the plant operating supervisor."—E. G. ACKHART, Chief Engineer, Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Delaware.

"In connection with every engineering work of any importance, there is always a time at which its eventual success, or its immediate abandonment, depends on the preparation of a convincing report. Thus, the ability to express facts clearly and ideas convincingly is necessary for any engineering undertaking and contributes greatly to the personal success of an engineer."—ERNEST L. ROBINSON, Turbine Engineering Department, General Electric Company.

"There is no doubt as to the very great importance of both written and spoken English to the engineer. Contacts which I have had recently with practicing chemical engineers and chemical executives have brought this especially to attention. These men think and feel that one of the great handicaps under which the young engineer, as well as the older man, is laboring is the inability to write and speak good English; especially inability to write a good engineering or research report, or to present ideas clearly and satisfactorily to their superiors by speech.

"The importance of English to the engineer lies in two directions: first, in the ability to prepare a systematic, concise, and intelligent report or article employing good English; secondly, in the development of the man culturally and on the personal side. The first is concerned with the practice of his profession; the second, with the broadening of himself. In connection with the last, the ability to understand and appreciate literature, particularly modern prose and poetry, and to read these with understanding should be developed in the student during his college career. This would tend to improve the value of the man to his profession as well as to society in general."—J. C. ELGIN, Associate Professor of Chem. Engrg., Princeton University.

"The ability to express his views clearly and concisely is of paramount importance to the engineer. To do this he must have a competent grasp of the engineering problem involved and a capacity to so present the problem and his recommendation that others will be convinced of the soundness of his position. These two factors—professional competence

and ability for expression—are interrelated and of nearly equivalent significance."—Professor WALTER G. WHITMAN, Massachusetts Institute of Technology.

"I believe that a command of good English holds a position second to none in the equipment of the engineer."—ROBERT THURSTON KENT, Consulting Engineer, Verona, New Jersey.

"Next to the proper teaching of fundamental physics and chemistry, it has seemed to me for a long time that English is the most important subject.

"As an employer of men, it is constantly evident to me that college graduates have not been impressed with the need for a ready command of written and spoken English. If this were done, their progress after graduation would be materially improved."—ALFRED IDDLES, Babcock & Wilcox Co., New York, New York.

"English is in my estimation quite as important to engineers and scientists as mathematics and physics. Since we necessarily think in words, it is essential that our ability to use words, to assemble them in logical and exact sentences, be cultivated and trained along with our other talents. Unfortunately engineers seem to feel that their works speak for them and on this account neglect the art of self expression. This handicaps individual growth and development upon which progress of the profession depends.

"Lack of accuracy of expression and forceful presentation characterizes most engineering and scientific manuscripts. This unduly handicaps those who must later plod through pages upon pages of murky English to find the germ of the fact they need. Examples of absurdities in English abound in manuscripts submitted to (and sometimes published in) our technical periodicals."—D. H. KILLEFFER, Contributing Editor, *Industrial and Engineering Chemistry.*

"When it is considered that all of the ideas of an engineer, as well as any other professional man, must be expressed in the English language in order that they be understood by his associates, the importance of a good working knowledge, including correct and accurate usage of words, is evident. . . . English is a most important tool, particularly for expressing one's ideas, and accuracy in the use of language, both written and spoken, is an absolute essential for success in engineering, as well as any other profession, such as law."—Professor GEORGE G. BROWN, Dept. of Chem. and Met. Engrg., University of Michigan.

"As a minimum, every engineer should be taught enough English to avoid the gross errors of grammar and usage which can be heard at every technical meeting, and it would be a happy event if they could also realize that their opportunities would be greatly enhanced by acquisition of the ability to express their thoughts clearly, precisely, in good order, and with that degree of skill which makes agreeable reading."—JAMES G. VAIL, Philadelphia Quartz Co., Philadelphia, Pa.

"I believe that the study of English is a matter of great importance to all students of engineering. There is no profession in which the ability to express the writer's meaning in clear and unmistakable language is more important than in engineering."—DANIEL W. MEAD, Consulting Engineer, Madison, Wisconsin.

"I feel that too much emphasis cannot be placed on the teaching of English in engineering schools.

"The importance of a good English course in college seems to me to be unquestionable. In addition to the enjoyment which comes from familiarity with, and appreciation of, worthwhile literature, the engineer must consider the very practical matters of writing and presenting numerous reports and technical papers. Far too many technical graduates, whether engineers, chemists or physicists, do a miserable job in preparing papers and reports. Their ability in this direction seems to bear no definite relation to their technical ability. . . . In general, these men make little effort to choose a form or style which would be most acceptable and interesting to the general reader."—I. MELVILLE STEIN, Leeds & Northrup Co., Philadelphia, Pa.

"As a subject in the curriculum of an engineering school English is, at the very least, of equal importance with the technical subjects it includes. In some respects English is the most essential.

"To be a good technician a man must be able to express his views clearly, logically, and forcefully. For this he must know his language—his English. No matter how able one may be as an engineer his over-all value in the world depends on his ability to express himself."—THADDEUS MERRIMAN, Consulting Engineer, 346 Broadway, New York.

"Based on my own experience I can say that the engineering school graduates of the present day seem uniformly to lack a useful acquaintance with the English language and its spoken and written presentation."—A. E. MARSHALL, Consulting Engineer, New York, New York.

"I was taught English at the University of . . . and had to do such things as read Whittier's 'Snowbound.' In the examination I had to define words which were used by Whittier. Two of these were 'amaranth' and 'palimpsest.' Do you know what they are? Anyway I didn't and missed a number of other things, so that I did not pass the course and had an awful struggle. I later took a post-graduate course at . . . University and had to take English there. This course consisted in writing daily essays or compositions, one page long, about any subject that came into my head, which were corrected by an instructor on the basis of his ideas of elegant English. This was supposed to teach me to write gracefully using the proper figures of speech according to what was left of the old-fashioned rhetoric.

"I have done a great deal of writing since I left college, but I feel that the value of the two courses was zero. An engineer has to do a great deal of writing. If it is gracefully elegant English, it is usually hard to understand. What are needed are direct, simple statements, with no floweryness whatever. If instruction in English could be given with

little or no attention to literature, and with the principal emphasis on clarity and ease of understanding, the course would be very important to the prospective practicing engineer."—SANFORD A. MOSS, Thomson Laboratory, General Electric Co.

"Mere knowledge does not suffice in engineering practice, whether the worker be an employee of a company or an individual in consulting activity. The engineer's ability to convey his technical knowledge to his associates, to principals, and to others concerned in his work is almost as important as the having of the knowledge. The engineer must, therefore, be able to use English clearly, effectively, and easily. Otherwise he will be handicapped in his technical work.

"A knowledge of English literature, as of other cultural subjects, is almost equally necessary. In large measure the personality of the engineer, influenced by his general knowledge and his culture, is an important factor in his reception and his success. The teaching of English to engineers merely as a tool is not enough. A cultural acquaintance with and an appreciation of the literature should be taught also."—RUSSELL S. MCBRIDE, Chemical Engineer, Washington, D. C.

"I have a section in my files labelled 'Why Engineering Students Should Study English.' There I collect and preserve the rarer bits of rape and mayhem which more or less prominent engineers have inflicted on the mother tongue through the medium of the printed word. I don't believe I am stretching the truth any when I say that the average engineer's use of English borders on a disgrace. It is not merely due to neglect; it is sometimes due to active opposition. In some groups of technical men the proper use of language is the mark of a sissy.

"I hear a great many talks, speeches, addresses and papers by various kinds of people. The average technical man reaches an all-time low in such activities. I don't believe that it is because he lacks ideas or is afraid of an audience but because he is afraid of words—he isn't used to using them to express ideas.

"The first duty of an engineer is to have ideas. The second is to be able to communicate them to some one else. That's where he should use English—at least occasionally."—C. C. FURNAS, Associate Professor, Dept. of Chemical Engrg., Yale University.

"We probably had over a hundred employment men here in Urbana during the last two years. Each and every one of these gentlemen asked for men who not only knew the fundamentals and had the ability to apply them to practice, but also, they invariably wanted a man who could express himself clearly and concisely."—D. B. KEYES, Dept. of Chemistry, University of Illinois.

"I am of the opinion that the greatest shortcoming of most members of the Engineering Profession is their inability to express themselves understandingly and concisely.

"Their tendency is to write long, involved sentences and paragraphs in which various parts of the main idea may be widely separated by parenthetical insertions of detail. This tendency is quite evident in most

engineering reports. I believe that in some part this may be due to a too limited vocabulary, caused by the lack of sufficient practice and instruction in composition."—N. E. FUNK, Vice-President, Philadelphia Electric Co., Philadelphia, Pa.

"I question if it is possible to overestimate my opinion of the value of both written and spoken English to a practical engineer, or to technical men in general. My appreciation of its worth is probably occasioned by the all too numerous instances in which we find exhibitions of poorly expressed thoughts or serious grammatical errors.

"None of us I am sure can think of a technically trained man holding a position worthy of his ability who fails to express his views clearly when speaking or writing. We can only estimate the number who have failed to receive recognition as a consequence of a lack of this ability."—HIRAM S. LUKENS, Director, Dept. of Chemical Engrg., University of Pennsylvania.

"Success in modern industry depends on cooperation. This in turn can be secured only by making the other fellow understand and appreciate one's point of view. While success in getting cooperation depends on far more than words, without ability to use them effectively, success can never be achieved. If one could only get the engineering student to appreciate this situation, it would become possible to hold his interest in English and develop his capacity to use his mother tongue."—W. K. LEWIS, Dept. of Chemical Engrg., Massachusetts Institute of Technology.

"To the practicing engineer the mastery of mathematics and English is of paramount importance. The ability to appraise accurately and think quantitatively, coupled with the art of systematic and logical exposition, is an invaluable attribute. Indeed, in retrospect it is usually found that these qualifications have been the stepping stones to success.

"The practicing engineer has services and ideas to sell and must, furthermore, be able to report on assigned responsibilities. It is a human trait to associate these past accomplishments and potential achievements with the clarity, conciseness and accuracy of expression and presentation."—P. H. GROGGINS, Senior Chemist, U. S. Dept. of Agriculture.

"I presume that when engineers talk and write about courses in English for engineering students they have in mind the question of English as a tool. It is obviously important for anyone almost regardless of the field of endeavor in which he is engaged to be able to express himself clearly both orally and through the written word. Anything that can be done to cultivate the art of good expression is bound to be of importance. From my own experience I have considerable doubt if many of the English courses given at technical schools are of much help in this direction."—BARNETT F. DODGE, Prof. of Chemical Engrg., Yale University.

"It is a matter of common experience, unfortunately all too frequent, to read a badly organized, badly written report, or to listen to an ineffective presentation by an engineer who has an excellent grasp of the technicalities of his subject, but who has never been trained in the funda-

mentals of English nor in the art of expressing himself. Not only does such an engineer create a poor impression, which may be detrimental to his principals and to his own standing, but he may be misunderstood in some essential point, a circumstance that may easily lead to trouble and waste of time and money."—LOUIS C. HILL, Quinton, Code and Hill-Leeds and Barnard, Civil Engineering, Los Angeles, California.

"Every engineer should be able to write correctly, clearly and concisely and to speak properly, logically and effectively. The engineer who can neither prepare a good report nor make an effective oral presentation of his ideas, finds himself very seriously handicapped in his professional work."—F. H. RHODES, Dept. of Chemistry, Cornell University.

"Engineers as a class are none too proficient in their ability to prepare reports on matters coming within their province. The importance of educational training in this field takes equal rank, in my opinion, with any technical subject which might be mentioned in the usual curriculum of engineering schools."—FRANK F. FOWLE, Frank F. Fowle & Co., Consulting Engineers, Chicago, Illinois.

"I believe that it is most important that the engineer be able to express himself in the best English; not merely in grammatical English, but in a way that carries conviction to his hearers."—H. O. CHUTE, Chemical Engineer, New York, New York.

"The young man who has chosen engineering as a career ought to be able to think straight and to reach logical conclusions. If he has also the training to permit him to express himself clearly in writing, his equipment will be vastly improved.

"When he reaches the engineering world outside, if he learns to express himself clearly, tersely and convincingly, he will inspire confidence and invite further responsibility. The ability to express himself well on paper leads to confidence in verbal presentation, especially if one has preceded the other on a given job, and he will then take no more of the boss' time than necessary for reaching conclusion and action in conference.

"Granted proper technical training, the engineering student who can use with facility both the written and spoken word is certain to win advancement, with corresponding compensation."—G. L. KNIGHT, Vice-President, Brooklyn Edison Co., Inc., Brooklyn, New York.

"My experience in the past 20 years in preparing and publishing articles of a semi-technical nature in *The American City Magazine* and for the past 17 years in similar work in the construction field for *Contractors and Engineers Monthly*, has convinced me that engineers are, as a rule, very poorly prepared in both spoken and written English.

"I feel that engineering students should receive more training in the use of words and an endeavor made to increase their vocabulary beyond strictly technical terms."—THEODORE REED KENDALL, Editor, *Contractors and Engineers Monthly*, New York, New York.

". . . in many cases the lack of aptitude in the use of written English is the cause for the failure to carry to the interested people the message involved. Engineering reports of one sort or another are the only method of communication in many cases, and unless they are expressive and properly written they do not allow the interested people to obtain a conception of the work they purport to report."—DONALD F. OTHMER, Dept. of Chemical Engrg., Polytechnic Institute of Brooklyn, Brooklyn, New York.

"The ability to make oneself understood is a precious quality. The lack of this ability is a serious deterrent to one's progress and to one's ability to get a job done; the possession of this ability is an asset that is recognized and appreciated by both superiors and subordinates.

"This ability of articulateness should be both oral and written. Some technical men are articulate orally but not in writing; with others the reverse is true. In far too few cases, is a technical man sufficiently articulate in both mediums. In most cases, he is both tongue-tied and pencil-tied—an articulate cripple. The successful technical man has realized the necessity for articulation and has overcome any inabilities he may have had originally in this characteristic. Every technical man, the technical apprentice who has just emerged from school into practice and the technical executive, is called upon to express himself both in writing and orally. It is, therefore, absolutely essential that every young technical man make every effort before graduation—or certainly after graduation —to increase his articularity."—From a manuscript of JOHN H. PERRY, "The Technical Man and His Job."

"The engineer who cannot write and speak *effectively* is seriously handicapped. He can rarely hope to attain executive responsibilities or salary. He must expect, during his working life, to earn from $20,000 to $30,000 less (total) than an otherwise equally qualified engineer who has these abilities in good measure."—PHILIP W. SWAIN, Editor, *Power* Magazine, New York, New York.

"The engineer must be able to tell of his work accurately and confidentally before committees in an industrial organization or before city councils or committees investigating projects in which the engineer is seeking employment or is employed. A good knowledge of English both written and spoken is an indispensable need of the engineer and courses in the subject should be required in all engineering schools."—EDWARD BARTOW, Dept. of Chemistry, The State University of Iowa.

"The engineer must express his ideas clearly and forcibly in order to convince his fellow men and he must prepare reports which are both concise and logical. Regardless of ability, the failure on the part of the engineer and scientist to convey their ideas, is quite likely to close doors which are wide open to one who is able to write and speak with ease and some degree of elegance."—EUGENE C. BINGHAM, Department of Chemistry, Lafayette College.

"The English language is the only tool of expression available to engineers for communicating their ideas and achievements to other people. In such work it is of the utmost importance to avoid sloppy and muddy expression that confuses the reader instead of informing him. . . . One has only to attend the average convention of engineers to see the marked difference between men who can think and speak on their feet and those who cannot. The latter fail wholly to transmit their ideas no matter how well they know their subjects."—H. C. PARMELEE, *Engineering and Mining Journal,* New York, New York.

"I believe that English is of secondary importance to the practicing engineer in the sense that perfect command of a language will not compensate for any lack of straight engineering ability. On the other hand, the good engineer has a very real and definite need of the ability to properly present in writing his ideas and the results of his work."—EDWIN M. BAKER, Prof., Dept. of Chem. and Metall. Engrg., University of Michigan.

"An engineer, wherever he is placed after he has gotten started from the bottom, and whether he is in the field of design, research, operation, administration, sales, teaching, or what not, if he is to get his points over and get the support that may be necessary, must have a good command of English, and at least a reasonable degree of culture. Not only must he be able to express himself clearly in writing, but there are many occasions when he must stand on his feet and speak to groups large and small, whom he is trying to convince as to the soundness of his ideas."—ROY V. WRIGHT, Managing Editor, *Railway Age* Magazine, New York, New York.

"I believe that in general, engineers, especially the older men, should be able to both write and speak on engineering subjects more effectively and more concisely than they do. I believe the younger men are better trained in this respect than the older men. . . . It is my belief that less time can be devoted to the technical subjects and more time to the cultural subjects, including English, and thus have the college graduate better prepared to enjoy life and be a more useful citizen after he leaves college, expecting that he will obtain a great deal of his engineering knowledge in the practice of his profession in the branch in which he may later find himself engaged."—WILLIAM W. BRUSH, Editor, *Water Works Engineering,* New York, New York.

"The practicing engineer makes about the same use of the English language as is made by those in other occupations. I do not see that his needs are greater than nor that they are less than nor that they are essentially different from those of business men, lawyers, doctors, or those in government service. I consider it very necessary to have it definitely understood that there is no such thing as 'engineering English.'

"Just as in other practical fields, the professional requirement is primarily for precision of diction and clearness of style and only secondarily for elegance of diction and beauty of style.

"In general the engineer has no very great professional need of a conversational style in writing. The statement just made does not imply in any way that the engineer differs from anyone else in needing a general knowledge of poetry or an understanding of the types of fiction or of forms of play-writing. The engineer should be a broadly educated man whatever—if anything—this may mean; I think no professional man needs a broader education. I have relatives in most of the professions including the teaching of English. Of all of them, I'll bet that I get the most thrill from a sentence well phrased; I would have been cheated of one of the most joyful elements in my life if I had not come in early contact with men who knew and loved Addison, Stevenson, et cetera, et cetera—and who taught me to love them."—HARDY CROSS, Prof. Civil Engineering, Yale University.

"I have talked to a great many chemical executives and they all insist that chemists and engineers must have a good command of English and be able to express their thoughts clearly and originally."—W. T. READ, Dean, School of Chemistry, Rutgers University.

"The quality of English which a person uses marks and classifies an individual in an intellectual or cultural scale as is done by nothing else. Any educated man should strive to use well that medium whereby his level may be determined. Surely there is no basis for an assumption that an engineer should be content with a lower standard of proficiency in the English Language than any other educated man. If he neglects this most important element of his education or,—what is more serious—if his college or university neglects it for him, it may result in an inability to prepare acceptable reports or he may be incapable of association on equal terms with other educated persons."—FRANKLIN THOMAS, Chairman, Division of Engineering, California Institute of Technology.

"An engineer is generally looked upon by the public as a rather uncouth, rough and ready sort of a fellow. This view, although unfortunately true at an early era, is rapidly becoming extinct. Today, engineering is a profession and competition is keen. The engineer finds that keeping up with his profession requires going places and meeting people. He must be on the alert at all times for an opportunity to advance himself. It is necessary for him to join in the conversation and voice his views with decorum. This can only be done through the medium of words and a mastery of the English language."—EDWARD E. CLEMENT, Attorney and Counsellor at Law, Washington, D. C.

"It is extremely important for engineers to learn to be able to write intelligent reports, expressed in good English—and not too verbose. In other words, the report should be concise and to the point. . . . I feel that a proper training in English literature, from a cultural point of view would be of great advantage to engineers. In fact, I am a great believer in the advantage of cultural training to all professional men, not only in a business way, but also for their personal happiness. No professional man should be without some cultural training, but a thorough knowledge

of the English language is perhaps the most important."—CHARLES L. REESE, Consulting Engineer, Wilmington, Delaware.

"Life happens to have thrown me into contact with many executives who employ engineers. Almost without exception these executives have complained about the inability of the average engineer to speak or write good English. In these complaints they do not have reference to what might be called literary English: they refer to the inability of their subordinates to present clearly written reports and to make a simple but clear verbal report.

"I have served as the head of several groups of engineers engaged in research. In each case I have found it necessary to enter upon some sort of educational program directed toward the production of satisfactory reports. Experience in such work has shown me that engineers can be educated along such lines if sufficient effort is expended."—C. F. HIRSHFELD, Chief of Research, The Detroit Edison Co.

"In my experience of many years in engineering work I have contacted a large number of engineering graduates, and it has been my experience, and I have commented upon it many times, that a large percentage of the engineering graduates are unable to express themselves clearly and convincingly in written reports and letters or in discussion. As a part of the English course I believe instruction in public speaking should be included so that engineering graduates can present their ideas effectively, not only to other engineers or technologists, but to laymen. It seems to me that clean-cut well-chosen speech indicates clean-cut thinking. The growing complexities of technology emphasize the importance of concise, clear statement and exact definition to avoid dangerous ambiguities leading to false conclusions and perhaps disastrous technical and economic results."—P. E. LANDOLT, Chemical Engineer, New York, New York.

"One of the great difficulties we find in chemists and engineers is their great aversion to writing reports, and when they do write them they are generally abominable from two points of view—one, organization and second, English. They lack ability to organize the material studied and are greatly lacking in logic and English expression. Likewise, when they are requested to abstract articles to bring out the salience in simple English, the results are frequently opposite to what the author had written; and some abstracts are longer than the original articles."—GUSTAV EGLOFF, Universal Oil Products Co., Chicago, Ill.

"The engineer . . . has frequently to formulate agreements and draw contracts and specifications between consumer and producer. On the interpretation of these agreements and contracts both the quality of the work and its cost are dependent, and the thorough knowledge of the meaning of his agreements is, of course, very important to the engineer.

"As a professional man who is active in his profession, the engineer may write papers to professional societies; the language of the papers and the character of their presentation will enhance the value of these papers almost as much as their subject matter. The engineer will also

find in the cultivation of language and in its inherent logic a fruitful field for thought."—LEON S. MOISSEIFF, Consulting Engineer, New York, New York.

"During the past several years I have had occasion to talk with and to read reports written by a considerable number of recent engineering graduates. As a whole I would say that these men have been notably ineffective in their use of English.

"The practicing engineer must be able to work with others, to coordinate his efforts with theirs. He must be able to explain what he is doing, why he is doing it, and what he has found out. If he cannot do this in clear, concise language, his effectiveness is reduced. Moreover, through practice, he must learn to go beyond his own individual approach to the subject, and to present it from a general viewpoint so that others may understand him."—R. L. COPSON, Dept. of Chemical Engrg., Tennessee Valley Authority, Wilson Dam, Alabama.

"English is important to the practicing engineer three ways, as I view it: (1) In his ability to write a report that will clearly and tersely, yet not arbitrarily state his views, ideas, conclusions and recommendations to a client, or an employer, in such a way as to have the reader clearly understand the subject matter presented without ambiguity. (2) In a presentation of his ideas orally, that is, with ability to think on his feet and to express himself in fluent, descriptive English. (3) In daily correspondence and memorandum and in routine work."—HAROLD V. COES, Consulting Engineer, New York, New York.

"Because of my views as to the nature of the engineering profession, I cannot do otherwise than to regard English as a critical part of an engineer's equipment. I make a distinction between engineers and scientists, with whom I think language equipment is not so important.

"If an engineer's training neglects the great human mirrors of history and languages, particularly his own language, if his mind and heart are not sensible to the great social forces of his day and of his community, if he but feebly develops the subtle qualities of character that make for personality, his career as an engineer is limited, no matter how much science he may know."—GANO DUNN, Consulting Engineer, New York, New York.

(*Continued in the April* JOURNAL OF ENGINEERING EDUCATION)

CIVIL ENGINEERING DIVISION

H. C. Bird, *Chairman* — P. P. Rice, *Secretary*
H. E. Babbitt — H. Sutherland
F. T. Mavis — H. T. Heald

COMMITTEE MEETINGS

Harold C. Bird

Three important meetings of the Civil Engineering Division were held in New York during the third week of January.

The first meeting consisted of a get-together of the members who attended the Surveying conference last Summer and about which more will be found in the March issue of the Bulletin. After an inspection trip, they were entertained by Professor Dodds with one of his inspirational talks. This group is planning to hold another conference in 1940. In the meantime they are arranging for a series of short local conferences to be held in connection with the various regional meetings of the Society.

The Structural Engineering Committee at its meeting went on record as being in favor of holding a conference on Structural Practice this Summer in Chicago prior to the annual meeting. Past-Chairman Grinter was asked to take charge of the conference in coöperation with the members of the committee. The executive committee of the division approved the request and the chairman was instructed to make formal request for the desired permission. Up to this time the Chairman has not been informed of the final action of the Executive Committee of the Society.

At a meeting of the divisional executive committee the request of the structural engineering committee was approved and the Chairman instructed as above. Following this definite plans were made for the meetings of the division at College Station, Texas. These plans have since been revised as the division has been granted one less day for its meeting than it had last year. The present tentative plans for the meeting are as follows:

June 27–30, Inclusive

1. Monday morning, 9:00 o'clock, general session, report of Library Committee, "Economy as Applied to Civil Engineering," breaking up into three sections at 10:15 on: (*a*) Hydraulics, (*b*) Transportation, (*c*) Construction Education.
2. Monday afternoon, 2:00 o'clock, general session, with two talks of an inspirational nature on Civil Engineering, followed by a general session on Soil Mechanics.
3. Tuesday afternoon, 2:00 to 3:15 o'clock, joint session with the Division on Research, followed by a general Civil Engineering session, to be given entirely to the problems of the young instructor in Civil Engineering.
4. Wednesday afternoon, 2:00 o'clock, general session on Educational Methods, breaking up into three group discussions at 3:15 on Surveying, Structures, and Sanitary Engineering.
5. Monday evening, the annual dinner of the Division, which includes a business session followed by a general good time, at which dinner we hope to have E. P. Arneson take charge of the program.
6. Tuesday, noon, the Divisional Luncheon, at which there will be no formal program.

ENGINEERING ECONOMY PAGE

Engineering Economy deals with comparisons between technical alternatives in which the differences between the alternatives are expressed as far as practicable in money terms.

Extracts from a letter sent July 25, 1935, to Professor Paul T. Norton, Jr., by Dr. Dugald C. Jackson.

"As I understand the situation, the technical sense of the word 'economics' is the same as the technical sense of the phrase 'political economy,' and distinguishes the material aspects of the social organization from the sentimental and moral aspects which belong in the domain of philosophy and religion. This is a very wide and important field, and is one in which engineering has a great influence.

"On the other hand, the word 'economy' as ordinarily used means the specifically advantageous use of dollars and cents, and represents a very limited field compared with the field of economics. Of course dollars and cents also come into the field of economics in a very high degree. For illustration, this nation went on year after year putting many billions of dollars into the extension of fixed plant, prior to the depression, without any careful foresight as to what unbalancing of the conditions of life might be brought to pass by expenditure for fixed plant in excess of the nation's annual savings. Of course this very deeply affects the ultimate status of the social organization and is a matter of political economy, although it is also a matter of dollars and cents. However, the question of whether or not you and I shall have our houses painted this year or next year does not affect the social organization materially, when we are considering an individual alone, but it is a question of personal economy as to the best solution of the painting problem. If a painting strike arose amongst all resident owners, it might then become a question of political economy because it might affect the considerable use of materials and employment that are influential in the welfare of the general social organization.

"I think if engineers will keep these differences in the meanings of the words in mind, and keep reiterating the definitions as they use the words, a good deal of the misapprehension and difference of opinion that we now see will disappear."

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FRED W. SLANTZ, EDITOR

INFINITY IN DESCRIPTIVE GEOMETRY

RUSSELL A. HALL

Co-Chairman, Div. of Engineering, Union College, Schenectady, N. Y.

The human mind likes to think in terms of concepts which have a real or imagined physical existence. It seems easier to grasp mentally the significance of those concepts of which a fairly accurate model may be made, than it is to visualize those which are imaginary; that is, exist only in the mind. This trait of the human mind undoubtedly had some little influence upon the Newtonian conception of a universe which consisted of a mass of hard gritty particles, and which has so greatly influenced the scientific and philosophic thought during the past two centuries. Nevertheless, in twentieth century science, when the universe is being conceived as a quantity of energy carried upon electrons whose exact character is impossible to visualize; when time is relative and length depends upon the position of the observer, rather than upon some precise constant which may be seen in the archives, it may be more necessary than formerly to train scientific students to think in terms of the abstract.

In the subject of descriptive geometry the opportunity frequently arises to make use of the intangible, imaginary conception of infinity as a simple means of explaining definite and finite relations between magnitudes. Of course, it is possible to teach the subject without bringing in the conception of infinity and some teachers believe that this is the only practical course to follow. But those who follow such a course are losing an opportunity to give their students an insight into the kind of thinking which takes the pragmatic viewpoint that the test of the truth of a thing depends upon its usefulness, and not upon the ease or difficulty of producing a physical model of it. Is not infinity a very useful tool to use in explaining certain geometric conceptions and could not the conception of infinity be made a better means than it usually is at present, of giving a student a proper perspective of the utility of using abstract conceptions to explain concrete things?

H. WESLEY SAVAGE
Dept. of Engineering Drawing,
Lafayette College,
Easton, Pa.

The usefulness of a conception of Infinity in Descriptive Geometry is often tested by the inconsistencies and exceptions it enables one to overcome.

Consider the statement:

"Every straight line of a plane pierces any other plane *to which the first plane is not parallel* in the common intersection of the two planes."

Note that the emphasis is on the exceptions.

Change the statement to read thus:

"Every straight line of a plane pierces *any other plane* in the common intersection of the two planes."

A conception of Infinity overcomes the exceptions and ambiguities and directs emphasis to the rigorous principle.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The National Nominating Committee of the American Institute of Electrical Engineers, consisting of members from various parts of the country, has nominated the following official ticket of candidates for the offices becoming vacant August 1, 1938:

For President:	JOHN C. PARKER, Vice-President, Consolidated Edison Company of New York, Inc., New York, N. Y.
For Vice-Presidents:	
(North Eastern District)	CHESTER L. DAWES, Associate Professor of Electrical Engineering, Harvard University, Cambridge, Mass.
(New York City District)	F. MALCOLM FARMER, Vice-President and Chief Engineer, Electrical Testing Laboratories, New York, N. Y.
(Great Lakes District)	A. H. LOVELL, Professor of Electrical Engineering, Assistant Dean of College of Engineering, University of Michigan, Ann Arbor, Mich.
(South West District)	F. C. BOLTON, Dean of the College, and Vice-President, Agricultural & Mechanical College of Texas, College Station, Tex.
(North West District)	LESTER R. GAMBLE, Electrical Engineer, Washington Water Power Company, Spokane, Wash.
For Directors:	LELAND R. MAPES, Chief Engineer, Illinois Bell Telephone Company, Chicago, Ill.
	HAROLD S. OSBORNE, Transmission Engineer, American Telephone and Telegraph Company, New York, N. Y.
	D. C. PRINCE, Chief Engineer, General Electric Company, Philadelphia, Pa.
For National Treasurer:	W. I. SLICHTER, Professor of Electrical Engineering, Head of Department, Columbia University, New York, N. Y.

Revised Enrollment of Graduate Engineering Students, 1937–38, University of Wisconsin

Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others (Please name)	Total	Masters Degrees Conferred in 1935–36	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others (Please name)	Total	Doctors Degrees Conferred in 1935–36
14	7	8	—	29	22	2	7	—	—	9	6

Corrected Undergraduate Enrollment 1937–38, Columbia University

Freshmen (1st yr.)	Sophomore (2d yr.)	Junior (3d yr.)	Senior (4th yr.)	Total
110	195 *	58	53	416

* Includes 77 Juniors, 21 Seniors in College, preparing to enter School of Engineering.

COLLEGE NOTES

Case School of Applied Science.—Dr. Gerald M. Cover has been appointed Associate Professor of Metallurgy. Dr. Cover is a graduate of Case in the Class of 1924 and a former member of the Faculty. After graduating from Case in 1924 he accepted a position with the Weirton Steel Company at Steubenville, Ohio as a technical apprentice in the Open Hearth and Rolling Mill departments. In the fall of 1930 he was appointed as an instructor in metallurgy at Case and while teaching completed the requirements for the Master of Science degree which was granted in June, 1934.

Robert L. Shurter, Assistant Professor of English, will go to Boston next September as exchange professor for one year at Massachusetts Institute of Technology. Mr. S. Lanier will leave his position as Instructor in the English department at M. I. T. to take Dr. Shurter's place for the 1938–39 college year.

Dr. Shurter was graduated from Amherst College in 1928 and was awarded his Master of Science degree at Columbia University in 1935. He was appointed to the Faculty at Case in 1930 and has been there since that time with the exception of one year spent at Western Reserve University where he studied for his Doctor's degree. This was conferred on him in 1936.

Mr. Sterling Lanier is a graduate of Harvard University who has had a total of five years of teaching experience at Oglethorpe University and M. I. T. He has given courses in Public Speaking, Dramatics, and Music Appreciation in addition to English. He is an accomplished violin player and a member of the orchestra of the New England Conservatory of Music in Boston.

Cornell University.—The establishment of a school of Chemical Engineering, as the fourth constituent unit of the College of Engineering at Cornell University is announced. Dr. F. H. Rhodes, since 1920 professor of chemistry and chemical engineering at Cornell was named director of the new school, effective July 1.

The curriculum will consist of a five-year course leading to the new degree of Bachelor of Chemical Engineering. The facilities of the modern $1,500,000 laboratory given to the University by the late George F. Baker will be coördinated with those of the College of Engineering to train men, not only in chemistry but also for the design, development and operation of actual producing units in chemical plants.

The new school is the outgrowth of a series of courses in the past twenty-five years during which there has been an increasing demand for chemists on the part of industry. In 1930 a five-year course in Chemical Engineering was started and administered jointly by the Department of Chemistry and the College of Engineering. The enrollment in the course has grown so rapidly that while three seniors took the Chemical Engineering degree in 1932, this year there will be 14, and the total number of men registered in all five undergraduate classes is 158. Graduates are accepted by industry as having the equivalent of a master's degree from other universities, and all but one of the Cornell graduates now hold responsible positions in the chemical industry. Last year each senior had an average of four offers of positions. Cornell's chemical engineering curriculum is approved by the Engineering Council for Professional Development and the American Institute of Chemical Engineers.

Professor Rhodes, the first director of the new school is a graduate of Wabash College, receiving the A.B. degree in 1910 and the Ph.D. degree from Cornell in 1914. After several years spent in teaching at the University of Montana and Cornell, he was research chemist and chemical Engineer and director of research of the chemical department of the Barrett Company. He also acted as consultant for the Anaconda Copper Company, the Atlantic Tar and Chemical Company and other industrial concerns. He designed the refined products section of the main tar refinery of the U. S. Steel Corporation at Clairton, Pa.

Since 1920 he has been professor of chemistry and chemical engineering at Cornell and has been chairman of the committee supervising the curriculum in chemical engineering since its establishment. He is the author of "Patent Law," 1931, and of more than fifty articles on chemical and chemical engineering subjects in various technical journals.

Professor William N. Barnard has been named director of the Sibley School of Mechancial Engineering. A graduate of Cornell in 1897, he has been, with the exception of two brief periods, a member of the faculty ever since. Since 1907 he has been professor of heat-power engineering. He has been head of the department for eighteen years and during the past year and a half has been acting director of the Sibley School of Mechanical Engineering.

University of Idaho.—Professor J. Hugo Johnson, who has been Head of the Department of Electrical Engineering since 1918, has been appointed Acting Dean of the College of Engineering at the University of Idaho, to succeed Dean Ivan C. Crawford who recently resigned to become Dean of the School of Engineering and

Architecture at the University of Kansas. In addition to a long teaching experience, Professor Johnson has had many years of practical experience in the power field. He received both A.B. and E.E. degrees at the University of Wisconsin.

Professor Isaac Newton Carter has been appointed Acting Head of the Department of Civil Engineering at the University of Idaho to fill the vacancy created by the resignation of Dean Crawford. Professor Carter received his B.S., M.S., and C.E. degrees at the University of Idaho, and has taught there since 1923. As Associate Professor of Civil Engineering, he has been in charge of freshman drawing for some time.

John W. Gray has been appointed as an instructor in Electrical Engineering. Mr. Gray received a degree of B.S.(E.E.) from the University of Washington in 1935, and has held fellowships there for two years.

Massachusetts Institute of Technology.—The November issue of the *Journal of the American Chemical Society* contains an account of experiments carried out recently by Nicholas A. Milas and Sidney Sussman in the Department of Chemistry which set forth a catalytic method for forming alcohols from unsaturated (or olefinic) hydrocarbons. The success of this catalytic process in the laboratory is of considerable scientific interest, and it may lead to important improvements in commercial practice.

The major work of the Research Laboratory of Inorganic Chemistry is being directed at present toward the study of certain phases of natural and artificial radio activity. In coöperation with Professor R. D. Evans and his associates of the Department of Physics, several special problems of physical and chemical interest have been brought under consideration.

The age of a meteorite definitely believed to have reached the earth from outside the solar system will be determined by a combination of careful analyses. The infinitesimal content of protoactinium present must first be separated, so that physical measurement of its radioactive properties can be made. By a known mathematical relation between the amount of radioactive substance at any time and the rate of decomposition, the "life" of the meteorite may be determined. The results thus obtained will furnish the first evidence yet secured as to the age of objects in extra-solar space.

The subject of the trans-uranic elements—elements of atomic number greater than that of uranium (92), is also being investigated in this Laboratory, with the purpose of furnishing much-needed corroboration of the claims of European experimenters. It has been set forth that uranium, on bombardment with neutrons,

is converted successively into element 93 (eka-rhenium), element 94 (eke-osmium), and elements of still higher atomic number.

A technique is being developed whereby it is expected that the vapor pressure of very slightly volatile compounds of radioactive elements may be measured by determining the amount of radioactivity acquired by a known volume of an inert gas which has been slowly passed over the substance.

In addition to these problems on radioactivity, the Laboratory is engaged in the further study of some of the rarer elements, such as rhenium and indium; the preparation and study of the properties of organo-silicon compounds, the hydrides and other compounds of boron, and the metal carbonyls and related compounds.

North Carolina State College.—Blake R. Van Leer, formerly of the University of Florida, comes this year to be dean of the engineering school. Dean Van Leer is a graduate in electrical and mechanical engineering at Purdue, and holds a master's degree from California; he also studied at Caen and Munich.

Other additions to the engineering faculty include E. W. Winkler (B.S., Montana State, M.S., University of North Carolina) instructor in electrical engineering; R. J. Maddison (B.S. Newark), P. E. Moose (B.S., N. C. State; M.E., Purdue), and T. C. Brown (B.S., M.E., Kentucky), instructors in mechanical engineering; J. D. Lindsay (B.S., M.S., Ph.D., Michigan) and D. B. Wicker (A.B., Elon; B.S., N. C. State; M.S., Ph.D., M. I. T.) associate professors of chemical engineering; N. W. Conner (M.S., M.E., V. P. I., M.E., Iowa State) assistant professor in engineering mechanics.

The local branch of the Society has grown during the year to more than fifty members, now being one of the largest branches in the entire country. The group has planned a series of meetings, definitely scheduled during the school year and centralized about the thesis of improvement in instruction. Such topics are included as the relation of the basic division to the engineering school; the problem of teaching initiative; the four-year and five-year curricula; the teaching of mathematics to engineers; and a two-year terminal program for engineering students. All these topics are to be presented by members of the engineering faculty. The group plans also to have an address by President Earle or some other official of the Society.

The engineering faculty is likewise scheduling a series of meetings whose topics and speakers are supplementary to those of the society. The faculty also will hear authorities from the national department of education and personnel men from leading industries. At least one meeting will constitute an open forum.

Under the direction of the dean, the engineering school has given during the year a series of vocational lectures for freshmen. The engineering school has coöperated with the extension division of the college in promoting an institute for surveyors during January, leading directly into and coöperating with the annual session of the North Carolina Society of Engineers.

The engineering school has likewise coöperated with the public lectures committee of the college in bringing speakers to the campus, specifically Dr. D. C. Jackson, of Massachusetts Institute of Technology, who gave in January a series of six lectures on the engineer and civilization.

Officers for the local branch in the school-year 1937–38 are as follows: Chairman, H. E. Satterfield; Vice-chairman, R. B. Rice; Secretary, C. R. Bramer; Corresponding secretary, A. M. Fountain.

Enrollment in the engineering school for the Fall Term of the present school year is 922 as compared with 815 for the same term of last year.

Northeastern University.—Construction of the University's new Engineering Building is proceeding according to schedule so that it is expected the completed building will be ready for occupancy by next June. It will comprise a basement and four stories which will make available a total of 100,000 square feet of floor area. The Mechanical Engineering and Testing Materials Laboratories, Chemistry Laboratories, Physics Laboratories, and general administrative offices of the University will be housed in the new building. Provision has also been made for several large lecture rooms, drafting rooms, and a number of standard classrooms. This will permit the University to dispense entirely with rented areas and will enable all Day Division colleges of the University to be housed for the first time on a single campus. The corner stone was laid on November 15.

The following appointments have been made to the faculty of the College of Engineering since the opening of the college year: David L. Davidson (S.B., M.S., Ph.D.—Brown University), Instructor in Chemistry; Ralph D. Nelson (S.B.—Rhode Island State College, M.S.—Rennsalaer Polytechnic Institute), Instructor in Mathematics; and H. Theodore Silverstein (A.B., A.M., Ph.D.—Harvard University), Instructor in English.

Plans are being formulated by the Department of Civil Engineering for the establishment next year of laboratories in soil mechanics and hydraulic and sanitary engineering. Areas in the present Laboratory Building that will be vacated by Departments which will be housed in the new Engineering Building will be used for these purposes.

Oregon State College.—Additional courses in radio engineering in which the state owned radio station, KOAC at Corvallis, will be used as laboratory equipment, have just been approved by the Oregon State Board of Higher Education. This 1000 watt station is located on the campus of the college with studios and transmitting equipment in the physics building.

New courses include a three-credit course in radio engineering, a sequence of three one-credit courses in Radio Engineering practice, in which the engineer of the station will supervise actual operation of broadcasting equipment, and expansion of a three-credit course in radio speech to a sequence extending through the entire year. The speech course will make it possible for radio technicians to obtain sufficient training in studio work to handle combination positions in small stations and to understand the problems involved where they are not directly engaged in program work.

The additional work supplements the courses previously provided in the communications engineering option in the department of electrical engineering. These included nine hours in radio communication, nine in communicating engineering, six in vacuum tubes and circuits, and three in sound systems.

Rensselaer Polytechnic Institute.—Wynant J. Williams, professor of electrical communications, is engaged in an experiment in the use of short radio waves as a means of forecasting weather. The experiment is a co-operative one between the meteorological and radio research laboratory on Whiteface Mountain in the Adirondacks, operated by Rensselaer and New York University, and New England radio interests which have set up equipment in the observatory on Mount Washington, N. H., directed by Harvard University. The behavior in flight of short waves from Mount Washington to Whiteface is recorded at Whiteface on a chart by inked indicators automatically directed by forces received through the antennae of the recording apparatus. The behavior of the waves is being compared with weather conditions with the hope of correlating one with the other.

A new program of research in electric welding is under way at Rensselaer in a new laboratory made possible through a contribution of $20,000 by George T. Horton, president of the Chicago Bridge & Iron Company and members of Rensselaer's Board of Trustees. Professor Wendell F. Hess is in charge.

Rose Polytechnic Institute.—New members of the faculty this year are Frederic Henney, Captain, C.E., U. S. A., Professor of Military Science and Tactics; Weldon N. Baker, Ph.D., Columbia, instructor in chemical engineering, and Theodore P. Palmer, M.A., Harvard, instructor in mathematics.

Installation of the X-ray laboratory has been completed and new equipment in air conditioning and electronics has been added to mechanical and electrical laboratories.

Professor Greenleaf is continuing his research on the magnetic control of the hardening of steel with considerable success. His apparatus is being studied at present by one of the large instrument companies.

Rose will be host on May 7 for the annual meeting of the Indiana-Illinois section of the S. P. E. E. Professor O. L. Stock, of Rose, is president of the section for this year.

Professor Ralph K. Strong, of the department of chemical engineering, was the editor of the section on chemistry of Van Nostrand's Scientific Encyclopedia.

NEW MEMBERS

BARRIE, JOHN G., Instructor in Mechanical Engineering, New York University, New York City. S. K. Barrett, A. C. Coonradt.

BOYNTON, JOHN E., Professor of Mechanical Engineering, Vanderbilt University, Nashville, Tenn. W. B. Brown, F. G. Slack.

BREAZEALE, WM. M., Instructor in Electrical Engineering, Vanderbilt University, Nashville, Tenn. W. B. Brown, F. G. Slack.

CLOUD, WILBUR F., Professor of Petroleum Engineering, University of Oklahoma, Norman, Okla. N. E. Wolfard, J. F. Brookes.

DRIER, ROY W., Associate Professor of Metallurgy, Michigan College of M. & T., Houghton, Mich. G. W. Swenson, W. O. Ray.

GJESDAHL, MAURICE S., Associate Professor of Mechanical Engineering, Pennsylvania State College, State College, Pa. A. H. Zerban, L. A. Doggett.

GREENSTEIN, PHILIP, Instructor in Electrical Engineering, New York University, New York City. S. K. Barrett, Harold Torgersen.

HAMILTON, ERWIN, Associate Professor of Automotive Engineering, New York University, New York City. S. K. Barrett, A. C. Coonradt.

HUFFMAN, JOHN R., Assistant Professor of Chemical Engineering, New York University, New York City. S. K. Barrett, H. J. Masson.

HUNTER, MATTHEW A., Professor of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. S. B. Wiltse, R. A. Patterson.

LANGENHEIM, RALPH L., Dean of Engineering, University of Tulsa, Tulsa, Okla. Herman Schneider, G. W. Burns.

MCKEE, HARRY L., Supervisor, Evening Vocational Courses, Carnegie Institute of Technology, Pittsburgh, Pa. L. R. Guild, R. M. Ihrig.

MONTGOMERY, JAMES B., Instructor in Engineering, Arkansas State College, Jonesboro, Ark. F. L. Bishop, Nell McKenry.

NASH, THOMAS L., Instructor in Mechanical Engineering, North Carolina State College, Raleigh, N. C. H. E. Satterfield, C. R. Bramer.

NOLD, HARRY E., Professor of Mine Engineering, Ohio State University, Columbus, Ohio. re-admission.

PATTEN, LAWTON M., Instructor in Engineering Drawing, New York University, New York City. S. K. Barrett, E. C. LaValley.

RHODES, FRED H., Assistant Professor of Civil Engineering, University of Washington, Seattle, Wash. F. M. Warner, R. G. Tyler.

RUSSELL, DONATO L., Instructor in Mechanical Engineering, New York University, New York City. S. K. Barrett, A. C. Coonradt.

SCHAFFNER, ROBERT M., Graduate Assistant in Chemical Engineering, West Virginia University, Morgantown, W. Va. C. P. Boomsliter, W. W. Hodge.
VANDEGRIFT, CLARENCE G., Instructor in Mechanical Engineering, Pennsylvania State College, State College, Pa. A. H. Yates, L. A. Doggett.
WEISER, HARRY B., Dean and Professor of Chemistry, Rice Institute, Houston, Texas. J. H. Pound, L. B. Ryon, J. S. Waters.
WELCH, ERNEST R., Instructor and Head, Dept. of Electrical Engineering, Howard University, Washington, D. C. A. E. Richmond, D. E. Howard.
WHITAKER, MARTIN D., Instructor in Physics, New York University, New York City. S. K. Barrett, Norman Hilberry.

For Active Institutional Membership:
Virginia Military Institute, Lexington, Va.; Norwich University, Northfield, Vt.
For Associate Institutional Membership:
Kansas State Teachers College, Pittsburg, Kansas.

BOOK REVIEW

Handbook of Chemistry. NORBERT A. LANGE, 2nd Ed., 1802 pp., Handbook Publishers, Inc., Sandusky, O. $6.00.

The second edition of "Lange" includes a number of improvements and additions to a book that was widely adopted in its first edition (1934). There is probably no better or more convenient handbook of its type available.

It is unusually well indexed and contains a 248 page mathematical appendix. The latter is divided into 39 sections, including outlines of differential and integral calculus, common and natural logarithms of numbers 10,000 to 12,000 and four place antilogarithms.

The tables of properties of organic and inorganic compounds and their solutions are especially complete. There are also extensive tables of physical and engineering data that will prove as valuable for physicists and engineers as for chemists, *e.g.* combustion constants for gases, formulas for water softening, properties of alloys, formulas for gas and water flow, calibration data for thermocouples, coefficients of compressibility and expansion, etc.

The printing is clear and larger than in most handbooks, but the thin paper has made it possible to keep the book within a convenient size.

C. G. KING

NECROLOGY

BENNETT MATTINGLY BRIGMAN was born in Louisville, Ky., February 25, 1881, and died February 8, 1938.

Dean Brigman was educated in the Louisville public schools; duPont Manual Training High School; State University of Kentucky, now University of Kentucky; University of Louisville, B.S. 1908, M.S. 1912.

He was employed by L. & N. R. R., 1902–04; Instructor in University School, 1904–07; duPont Manual Training High School, 1907–16; part-time Instructor in mechanical drawing, University of Louisville, College of Arts and Sciences, 1912–16, 1916 appointed Instructor in Physics and Engineering Drawing.

At the University of Louisville, Dean Brigman organized the department and acted as Purchasing Agent, in dual capacity, in 1918. He evaluated property and equipment of the Dental College prior to its purchase by the University. He was Chairman of the Committee which recommended the introduction and government of fraternities and sororities in the College. At the request of former President A. Y. Ford, he studied various types of engineering schools and in 1924 prepared a prospectus of an engineering school. This was accepted by the James Breckenridge Speed Foundation for an engineering school at the University of Louisville. On March 4, 1924, B. M. Brigman was appointed Dean of the Speed Scientific School and given authority to proceed with its organization.

Dean Brigman was active in many societies. He was member of Council, 1925–28, and Vice-President, 1934, S. P. E. E.; Manager, 1934–37, National Vice-President, 1938, A. S. M. E.; Member Legislation Committee, 1932–, A. I. E. E.; Member of A. A. A. S.; A. S. T. M.; N. S. P. E., Vice-President, Kentucky Chapter, 1935; Engineers and Architects Club; Past President Louisville Optimist Club; Past Chairman, Electric League of Louisville; Chairman of Mayor's Committee on Smoke Abatement; Member of Accrediting Committee for A. S. M. E. on Engineers' Council for Professional Development. He was a member of Alpha Tau Omega, Phi Kappi Psi, Theta Chi Delta, and Sigma Tau.

Dean Brigman has been an active member of the Society for the Promotion of Engineering Education since 1923.

G-E *Campus News*

BEATING SWORDS INTO PLOWSHARES

WELL, not exactly swords into plowshares, but rather discarded rails, superheaters, and boiler tubes into steel for the overhead system of an electrified railroad line. In this manner the old steam railroad of the Witwatersrand Gold Mining Area was replaced by a completely electrified line.

Because of the rise in gold prices during the last few years, an increased suburban passenger traffic in that section of South Africa necessitated an enlargement of the railroad. Modern all-steel motor coaches built in England supplant the steam locomotives and wooden coaches, and a double track has been laid where only a single line previously ran.

Mercury-arc rectifiers made by the British Thomson Houston Company, an affiliate of General Electric, supply the power for the "Reef Scheme," as it is called, while 115 four-motor, multiple-unit car equipments were furnished by G.E. through the International General Electric Company.

The engineering and sales work on this project was done by several former G-E Test men. Many such opportunities are open to graduates of college engineering schools who have successfully completed the G-E Test Course.

AMERICA'S OUTSTANDING YOUNG ELECTRICAL ENGINEER

DR. CHAUNCEY GUY SUITS, research physicist of the General Electric Research Laboratory, in Schenectady, has been named by Eta Kappa Nu, honorary electrical engineering fraternity, as the outstanding young electrical engineer for 1937.

Born in Oshkosh, Wisconsin in 1905, Dr. Suits attended the University of Wisconsin and graduated from the Technische Hochschule in Zurich, Switzerland (Sc.D. '29). An ardent skier, he spends most of his spare time on the snowy slopes around upper New York State, but also finds time to indulge in woodworking, amateur photography, and playing a clarinet.

As a member of the Research Laboratory staff, his work has been on the fundamentals of electric arcs, showing how arc temperature can be measured by sound, and it was for this work that the Eta Kappa Nu award was given him. Other activities for which Dr. Suits is noted include the investigation of nonlinear circuits, high-pressure arcs, and the development of automatic tuning for radio receivers.

Last year the award was given to Frank M. Starr, U. of Colorado '28, G-E Test '29, who is employed in the Central Station Engineering Department of General Electric. The Test Course, of which Starr is an alumnus, provides a practical education supplementary to the theoretical knowledge obtained in college.

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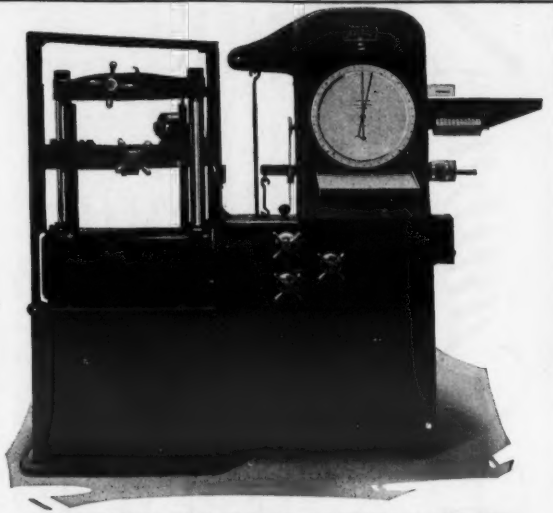

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